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MALLEABLE CAST IRON.

BY DR. RICHARD MOLDENKE, NEW YORK.

Whatever may be the scientific definition of a malleable casting for commercial purposes it is one made of iron of special composition and rendered malleable by subsequent annealing. The composition of the hard casting lies between well defined limits, and it is affected by so many conditions that the successful production of this class of work is one of the most difficult branches of the iron industry.

While nominally the composition of a good malleable casting is but little different than that of a car wheel or a roll, yet the fact that it can be twisted, bent and hammered out hot or cold and has double the tensile strength of these products shows that the constitution of the castings are quite different. This difference in the constitution may be traced to the condition of the carbon in each. In the ordinary gray casting we may have some 3 to 3½ per cent. graphite present. In the malleable casting we have the same amount, weighed as graphite in the analysis, but radically different in its characteristics. This form of carbon due to the annealing process has been called temper-carbon by Prof. Ledebur, who first described it in connection with the malleable (Ger. "temper") process. I will mention one of the pecularities of this form of carbon. If a malleable casting which on fracture shows the fine black velvet surface, is heated up very high and then plunged, all this amorphous carbon is dissolved, and the fracture shows the grain of a good tool steel. The same is often seen when a piece is hammered cold, and more especially when a casting that has become warped is heated up and straightened. The grain in the latter instances will

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not be as good as in the first one, but it shows that to straighten a malleable casting no heat, and preferable pressure only should be applied. This characteristic of the carbon is often used to palm off malleable castings as steel ones, much to the disgust of the user and the producer of bona fide "malleable".

Of the properties of the malleable casting, it may be said in general that the tensile strength should run between 42,000 and 47,000 lbs. per sq. in. Castings showing only 35,000 are still quite serviceable for ordinary work. It is not advisable to run much beyond 54,000 lbs. per sq. in., for the resilience is reduced, and one of the most valuable properties of the malleable casting impaired. I have made much work running up to 63,000 lbs., by the plentiful addition of steel to the mixture in the open hearth furnace. I do not, however, recommend this, as wherever such high results are wanted, they can best be obtained by using the steel casting direct.

As an instance of what can be done with malleable castings I will mention a series of tests made with bars of small and large diameters, which were heated and carefully drawn out under the hammer. While the interior, or high carbon portion was badly cracked up, the surface was of such a fine material that in one sample the tensile strength actually ran up to 123,000 lbs. per. sq. inch.

The elongation of a piece of good "malleable" will lie between 2½ and 5½ per cent. measured between points two inches apart. The thicker the piece, the smaller the elongation.

In making the transverse test, the deflection of an inch square piece, resting upon supports 12" apart, should be over ½", the breaking weight being at least 3,500 lbs. Very soft iron often deflects 2½" under this test, but this is exceptional and may not be reproduced continuously.

The high resilience, or resistance to shock, in "malleable" is its most useful characteristic. It is well-known in railroad circles that the ordinary steel casting comes no where near the malleable for service conditions. Only where an exceedingly high tensile strength is required, as in the car couplers for the heavy modern trains, is the malleable casting being gradually replaced. On the other hand, car castings, formerly made of gray iron, are now specified for malleable wherever possible, in the interest of greater

strength and reduced weight. When we remember that the present production of malleable castings is at the rate of 650.000 tons per annum, and at least half of this goes into car construction, the importance of the industy may be properly guaged.

In spite of this enormous production, there is really little information available outside of the foundries most interested, and it may as well be said, also very little within. The founder is not going to increase the difficulties in his sales if he can help it, and the inspecting engineer, not being able to check the process from his own understanding, cannot act as intelligently as he really should. The American Society for testing materials is, however, at present at work on this very thing, and we shall soon have a set of specifications governing the production of these castings where good qualties are essential, which will insure better work all along the line.

Before going into the composition of good "malleable," it is necessary to look a little into its structure. Originally cast to be perfectly chilled, that is with the carbon all combined, and a contraction of some ¼" to the foot; the annealing process serves to expel the carbon from its state of combination, depositing it between the crystals of the iron, not in the crystalling graphite of the gray iron, but as an amorphous form not unlike lamp black. At the same time an expansion equal to half of the original contraction takes place, the net result being a shrinkage allowance for the pattern identical with that for gray iron castings of similar shape and thickness.

Beside this expulsion of the carbon from its combination, there is a removal of some of it from the outer portions of the casting. This amounts to nearly all in the skin to nothing ¼" inward. I do not take kindly to the generally accepted theory that oxygen from the packing penetrates the casting, removing the carbon by burning it out. I have always found that when oxygen has access to the interior, through the open structure of the iron itself, this is also oxidized with the carbon, and the whole presents a sorry sight. Whether however, carbon difluses out or not, in a good casting, I cannot say, and hope that this point will some day be taken up and settled by careful experiment.

It will be noted that owing to the removal of varying amounts of carbon from the skin to the interior no carbon determination of

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a malleable casting is of any value, unless the sample is taken before the anneal, and even then it is only good for the total carbon. For an annealed piece a sample taken from the centre of the fracture with at least 3/8" untouched around the drill would give a fair indication of the carbon contents, but cannot claim accuracy.

In former days of charcoal iron about 4.00 per cent. carbon was the rule in malleable castings. In these days of coke irons and steel additions to reduce the carbon, this may run as low as 2.75 per cent. before trouble ensues in the anneal, if not already in the foundry through excessive cracking and shrinkages. With the modern demand for a high tensile strength it is well to place the lowest limit at 2.75 per cent. and the upper limit for common work would be found in the saturation point of this grade of iron, or 4.25 per cent. It is absolutely necessary that the hard casting be free from graphite, even a small amount of this indicates an open structure with consequent ruin to the work in the anneal from penetrating oxygen. To keep the carbon in the combined state is the function of the silicon percentage arranged for in the mixture, the rate of cooling due to the cross section, the pouring temperature, sand, etc.

The sulphur contents is quite important, especially just now when we are getting the sweeping of the coal mines for our fuel to a greater or less extent. The percentage should not be allowed to go over .05, though double this may let a casting pass muster where good work is of no special object. Once the suphur exceeds .05, trouble may be expected. It is therefore wise to hold the pig irons below .04, and to see that the fuel used is not too rich in sulphur.

Manganese is seldom troublesome, as it does not often exceed .40 in the mixture, which means .10 to .20 in the casting. Above .40 in the casting it begins to give trouble in the anneal and therefore manganese as a general proposition should be kept low.

Phosphorus should not exceed .225, and is better kept below this.

To get the proper silicon limit for the class of castings you have to make is the trick which means either success or failure for your foundry. This will be realized from the fact that you do not know how your casting will come out until about a week after they went into the anneal. Now suppose your mixture is wrong, and the silicon is either too high which means "low" or rotten work, or too low

in the castings, making them "high" (strangely contradictory but nevertheless shop terms in daily use and dating back to the times when silicon was unheard of in malleable works). This means hard burnt white castings stronger than the first mentioned class, but equally undesirable. You will not know of this until a whole week's work, in all probability equally bad, has been placed into the ovens, and comes out in its turn only to wander into the scrap pile. Naturally disaster stares the inexperienced founder of malleable castings in the face all the time, and only a good laboratory will keep him out of hot water, everything else being equal. It also shows the necessity for better protection to the buyer who cannot be supposed to distinguish between a good and only fair casting.

In general we may say that the thicker the casting, the lower the silicon allowable in order to get a white iron in the sand. Thus for the heaviest classes of work, the silicon of the casting should not exceed 0.45, For ordinary work .65 is the point to be sought for. Agricultural work may run up to .80 while the lightest casting may have 1.25 per cent without danger, though it is not advisable to exceed this limit for anything.

Our American practice differs from the European in several respects. We have a comparatively short anneal, that is we aim at a conversion of the carbon rather than its removal. Over there it is desired to get all carbon out, so that a wrought iron casting, if it may be so called, may result. With much of the iron cast from crucibles, it is quite possible to make very fine grades of work, and this may account for higher prices for malleable than steel castings paid in some parts of Europe. Imagine, however what would result if we had the crucible processes here, with our average production of some 35 tons daily in the larger plants, or some 80 in the very large ones.

The common American practice is to use the reverberatory, or "air" furnace, either with or without the top blast over the bridge to hasten the melting. There is always a blast introduced under the grates, unless indeed in our older works, the chimney draught is exceptionally good.

About 12 years ago the open hearth furnace was introduced into one of our largest works, and it was my good fortune to gain experience with it there. While not many malleable establishments

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have the open hearth furnace (I can count them on my fingers), yet it is undoubtedly the most economical melter there is, provided several things. One is that it must be kept busy as much as possible, as only then its full economy is taken advantage of. Then skilled workmen must be kept in charge. This does not mean the steel melter with his habit of letting the heat take care of itself, and tapping a ten ton heat five hours after charging, whereas it should come out in two hours and a half. But it means a man who will use his muscle freely to rabble up the heat, push the pigs into the bath as quickly as they can be cared for, mix his iron well, fire sharp and quick so that the process becomes one of melting only rather than a refining or burning out of large quantities of silicon and carbon. When these conditions prevail, the open hearth will prove a friend indeed and turn out a most excellent product.

Let us take fair conditions with three heats daily from a 10-ton open hearth furnace. Using producer gas the fuel ratio is about one of coal to six of iron. In the reverberatory furnace the fuel ratio is one to four at best, and often only one to two. It is not advisable to make larger heats than 15 to 18 tons, as the time consumed in melting, and especially in pouring from the small ladles after tapping, becomes so great that the bath is seriously damaged by undue oxidation and overheating. When the time comes for continuous melting in the malleable foundry, when heat after heat is taken off as fast as the bottom can be patched up and the furnace charged again, then will the complete economy of the open hearth furnace be fully realized. We may then also see the tilting furnace of value to us, though a device of my own, which I am using successfully in my own interests, and which allows the tapping from three spouts at different levels, successively, has the advantages of the tilting furnace for "malleable" without incurring the heavy first and running costs.

For making malleable castings, the open hearth furnace should be pushed very hard for a time almost sufficient to collapse it, then it should be checked before actual damage is done to crown and ports. In this way a short, sharp heat is obtained, the silicon of the heat may be calculated for a loss of twenty to twenty-five points whereas from thirty-five upwards is the rule in other processes. Three hundred heats should be taken off before repairs of several days' duration are required, and a total of at least 1000 heats only

should necessitate practically a rebuilding with but little loss other than the refractories.

In the meantime there has been much improvement in the air furnace. Strange to say, while the quantity of metal, the composition, excepting only in the phosphorus content, of the large roll and the malleable casting is the same, the air furnace used in each industry has been developed on different lines. In making rolls we find the short high reverberatory chamber, more on the lines of the copper furnaces, while in the malleable industry the furnace is long, very low, and contracted at the stack entrance. While formerly the hearth was practically rebuilt after each heat, at the present day several heats are taken off before a new bottom is made. The bungs, of course, always suffer, and herein the crown of an open hearth is much more easily cared for. But the poor efficiency of the fuel is an inherent difficulty which cannot be overcome, and presents new difficulties with every change of quality.

At the present time there is a general difficulty with the coal used, which means castings with an undue amount of sulphur. These castings are weak and will some day wander into the scrap pile. When the next slump comes we will be confronted with a serious condition. This high sulphur scrap will come into the market, in fact forced upon the founder wherever his castings can be identified. They will be hard to use by him, and from the fact of high sulphur will not be available for basic steel, as was the case formerly. There is then a neat problem, and one which will make the fortune of anyone who may discover an economical remedy, and that is the removal of sulphur from iron on a commercial scale. I present this to our experimenters and wish them success with it.

The cupola still turns out a considerable tonnage of malleable castings, but this process will be gradually superceded by the furnace method, chiefly on account of the better grade of work turned out by the latter. There is, however, one interesting point connected with the cupola process, or rather with cupolo iron, which we must go into more fully in connection with its bearing upon the anneal. Cupola iron requires some 200°F. more than furnace iron to anneal it properly. This is a general proposition. It seems strange that it should be so but possibly the structure of cupola iron is so close that is requires more effort to get the crystals apart and to ef-

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fect the liberation of the carbon from its state of combination. Whether this is due to the contact of the metal with the fuel as it trickles down in thin streams and drops is hard to say, but the difference certainly exists, and must be provided for in the anneal.

Naturally with a higher degree of heat the wastage of the annealing pots is more marked, and the process becomes more expensive in this regard also, for our annealing boxes must be reckoned as a dead loss which is to be diluted as it were by as long a life as possible in the ovens.

In studying the annealing process we find two extremes leading to about the same results so far as the carbon change is concerned. A short anneal at a very high heat is as effective as a comparatively long anneal at a much lower temperature. That is to say we can anneal, or rather change the carbon in a casting by placing it over night in a melting furnace which has been let cool below the melting point of the iron, or do the same thing in the annealing oven at a much lower temperature but giving it a week's time. Of the two methods the latter is by far the preferable, as it not only permits the change in the carbon, but also gives the carbon time to get out. Then again the chances of burning the castings in the anneal are obviated. The result is a good, reliable casting, while in the hurry-up processes one never knows whether they are annealed at all. Sometimes they are and often they are not. Malleable founders, therefore, while experimenting for generations on short annealing lines, have come to recognize that the best all around and safe method is to arrange matters so that an oven may be regularly recharged on the same day of the succeeding week.

We may describe the annealing process by a curve which runs up quickly, remains horizontal for a short time, and then drops very gradually. That is a sharp heating up, in the shortest safe time possible, then a shutting off of the dampers and maintaining of the temperature evenly for a period of say two full days at least, and then a gradual cooling down to at least a black heat before dumping. Here is where mistakes are often made, annealing pots being drawn red hot because some particular casting is wanted badly. The castings are red hot when the air touches them, the delicate reaction of the carbon is disturbed and an inferior material results. I have always had softer, more malleable iron from the

anneals which had the extra Sunday to become cold in the oven, and were cold when dumped on Monday morning.

An oven can be brought up to heat as quickly as may be, the fuel waste to do this being alone considered. In cities where the smoke problem exists, more time is required than in the open country. For a fair sized oven at least 36 hours are required to bring it up to heat. (a pyrometer should always be used to test this), and then it should be held there.

As to the actual temperatures there is this much to say. Furnace iron of average thickness must have received over 1250°F. after coming up, until cutting off the heat, to be safely annealed. Perhaps even then some of the work must be put back for another anneal. A safer limit is 1350° F, and no more is necessary. This temperature must exist in the coldest part of the furnace, or usually at the lower part of the middle in the front row pots. As a rule the upper space of an oven is some 200° F. higher than this, although I have succeeded in building ovens in which there was but a difference of 100° F. throughout the whole interior space the temperatures being measured with a LeChatelier element 20 feet long.

Translating these temperatures we find that 680° C is the lowest point for successful annealing of furnace iron, while 780° C is the safest one. For cupola iron the temperature should be about 850° C.

If we contrast former times with the present, in the malleable industry, when charcoal irons only were supposed to chill, when immense piles were kept at the command of some melter who had inherited the art of looking wise over the test plug, where would we have been today when the importing of foreign irons is the order of the day? In dollars and cents the benefit of science to the much neglected foundry industry has been incalculable, and perhaps the malleable foundry has received the greatest share, as it needed it most.

I cannot refrain from again calling attention to the fact that only education, and hard work to use this education properly, will allow us to hold the supremacy we have now wrested from industrial Europe. We must place our brightest young men in the technical schools, our apprentices in the evening and trade schools, and our children in manual training schools. Let those who have the

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making of future captains of industry be properly trained, and they will save many years of mistakes and wasted effort. Let the poor boy who wants to better his prospects in life be given the opportunity to enrich his store of knowledge. He will then see something ahead, and in times of trouble stand by his employer for justice and an unrestricted opportunity to receive full value for any increased output resulting from his skill and ingenuity. The foundry is a good place to study industrial conditions, and our hope for the future of the Nation lies in the education of our young men.

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THE TRIALS OF THE FOUNDRY FOREMAN.

BY A. M. LOUDON, NEW YORK.

The skill and endurance of the foundry foreman are constantly and sorely taxed in every phase of foundry life. Indeed he is in the unenviable position of being between two fires as it were, and life is therefore to him a pretty miserable affair.

It is with the idea of giving the foundry management on the one hand, and the men under his charge, on the other, a concise statement of the difficulties besetting the foundry foreman, that this paper is written. Perhaps in this way will the aid he seeks be extended and his efforts attended with complete success to his employers and satisfaction to himself.

Let us say a new order has been secured for the foundry. The foreman must at once figure on the best method of making the work as well as to produce it at the lowest cost. The ledger must necessarily show a profit so far as he is concerned. Now while doing this he must also direct the work of each man employed about the shop, must supervise the cupola gang, and see to it that the best results are obtained there. Next he must look after the molding proper, giving out the work and seeing that it is done; look after the core making, arranging things so that the cores will be made in time for the molds they are intended for; see that the molds are poured in proper rotation.

If to the above are added the daily conferences with the office, an even temper and smiling countenance can hardly be asked from the hard worked foundry foreman. It would seem further that if those who come into daily contact with the foreman would assist

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him wherever possible, perhaps he might cultivate the even temper which seems so desirable in business life.

From the preceeding it can readily be inferred that the foundry foreman has altogether too little assistance, and this is true whether it be a jobbing or a specialty shop. He naturally becomes a machine in the end, and if he breaks down in spirit, he is set down as a crank and certainly unfit to run a foundry.

The foreman has, however, also to contend with his men. Now I know that in most shops the foreman is fortunate enough to have some good, honest, conscientious and capable men working for him, and this is sometimes the only sunshine he has. They do not trouble him. But the majority of the help is always trying to see how little may be done before the law is laid down hard. Any effort on the part of the foreman meets with tacit resistance, and if the work is exacted in spite of this, every means arc resorted to, to drive him out.

On the one hand we have the foreman who allows the molder, helper, and core-maker to set the day's work. This man is not worth his hire. On the other hand we have the man in charge of the foundry who knows what a day's work should be, asks it from every one, and will not put up with a refusal unless it is actually shown an impossibility to him by honest effort. This foreman will turn out the shirkers.

Necessarily it will be seen that to do justice to the firm and the men is a delicate task, and the art is given to few. But here is just where ample assistance will help very much. Friction will be reduced to a minimum, and all the contending elements will be held down to strict business.

To get the best results from a good foreman, the management should give him its full confidence, back up his efforts to better conditions at all times, find out his troubles and wherever possible smooth the way a little so that the result gives some personal satisfaction to him and encourages him. Do not worry or ridicule the foreman, for he is the very man who worries most over losses, and does his best whether backed up or not, to reduce them, from personal pride. He will do all he can to keep up the production to the maximum, and if instead of worrying him when a loss does occur, and which worry will be sure to get him into such a state that he will lose the next time also, he is encouraged and let feel

that the management is with him in his efforts to locate and correct the trouble, a very happy situation will result.

Now a few words as to molders: The Golden Rule is just as applicable to them as to anyone else. Let the molders begin work in the morning promptly, taking the jobs given to them with the idea of the best interest of the management at heart. Who knows but that each molder's turn may come to be foreman some day too. He who may be depended upon to work conscientiously and intelligently has a foremanship ready for him when his time arrives. If molders would only keep this in mind, there would not be so many tyrants made in the foundries by their obstinacy and disregard for the interests of their employers. Would the molders only unite to help the foreman, how nice a place the foundry would at once become for honest, comfortable work. Truly where the management, foreman and men, are considered grouped together on one side, and the interests of the owners on the other, the trite saying, "United we stand, divided we fall," is very applicable.

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THE METALLURGICAL ENGINEER IN THE FOUNDRY

BY HENRY SOUTHER, HARTFORD, CONN.

The name is against him. It looks as though he would be a theoretical crank, that his ideas would be based on theories only and would conflict with common practice. This is quite possible. It is certain to be so unless his training has been a good one; unless he has step by step learned the actual details of foundry work. But if he has begun by getting into actual contact with every practical detail and has had a theoretical education, such that it has instilled into his mind the fundamental principles underlying all metallurgical processes; then by bringing these two educations to bear together he should prove a valuable assistant and adviser to the man who has not had these combined advantages.

Some foundrymen and managers in other industries feel that they may acquire this special knowledge and save the expense of expert service. Some do acquire such knowledge but they are the exception and not the rule, and even so it is my opinion that some important branch may suffer as a consequence and that a manager's time may be better spent. Some think they know it all and try it only to find that "a little knowledge is a dangerous thing" and then go back to old methods.

The case is directly comparable to that of the lawyer. All business men acquire or know more or less law. Some really are very well up in it and rarely have to consult a lawyer. Others think they are and do not seek expert assistance when they should do so, with the result that they get into legal difficulties from which some lawyer must finally extricate them at a far greater expense than would have been the case originally.

There is nothing more true than the fact that it is easier to keep out of trouble than get out of trouble.

A little money spent systematically for the services of a metallurgical engineer (not a chemist) pure and simple, may save far greater sums. It is very much in the nature of an insurance

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against loss. Conditions may seem so favorable for months at a time possibly; materials may be received of such uniform and satisfactory quality that money spent for expert services will appear to be wasted and therefore the plan discontinued. Then of a sudden may be received shipments of coke or iron, which had they entered the cupola would have ruined at least one day's product before discovery, and the loss would have paid an expert for some time.

This is not an imaginary occurrence but a real one, having come under my personal observation and into my hands as an expert several times. A matter of a thousand dollars in money loss, friction with selling agents, legal expense in connection with settlement of bills and greatest of all damage to the reputation of the foundryman as a producer of uniformly good iron.

I have excepted the chemist as noted in a previous paragraph from this argument and will show my reason for so doing.

A good chemist may be able to determine the amounts of the various elements in irons or fuels to the third decimal to the minimum limit of chemical error. He may be quick and do a large number of determinations per day. But of what use are results without practical interpretation and application? A chemist may become the best kind of a metallurgist but only by the one way I have referred to; personal contact with metallurgical operations in every detail and in several branches. A good share of common sense is a most valuable and necessary adjunct.

A metallurgist need not be a chemist but he must know how to use a chemist and the results obtained by the chemist. The chemist is an absolute necessity to the metallurgist.

The steel industry is the most marked example of an industry thriving under the care of expert metallurgists assisted by chemists. The two are rarely united in one person, each being busy in his own field.

Rule of thumb methods gave way to exact methods about 1870 in the iron and steel industry to a marked degree. Blast furnace practice from being a hazardous uncertain process full of difficulties became a process of certainty with the advent of technical knowledge. All because the furnaceman with his secrets gave way to the metallurgist and his open and exact methods, subject to the inspection of all concerned. Then of

course these same methods grew with the then infant steel industry and became an essential part of the industry. That which is common practice now would not be possible at all without the chemist to analyze under the direction of the metallurgist and with his interpretation of results.

Foundry and blast furnace practice is complicated in its reactions as compared with steel and really needs expert knowledge as much if not more than steel making, providing of course results anywhere near uniform are desired. Yet it is only of late that any expert knowledge has entered foundry practice of the general jobbing or manufacturing trade. It had been used as an accepted necessity by all foundries owned by the steel works or closely associated with them for many years.

The argument has been that the small foundry could not afford the services of a metallurgist because his output did not warrant the outlay. Or that the small producer has said it did not matter, his product was so small that it was not a necessity. As though what little he made might not be more important as far as quality is concerned than the crude product of a large concern.

It is no longer necessary for a foundry, large or small, to employ the exclusive services of a metallurgist. One may be found in nearly all the large manufacturing centers of the east or west who is at the service of the general foundry trade on very reasonable terms. As a rule these experts have their own chemical and physical laboratories; a necessity in nearly every problem under their investigation.

One without the other is helpless. As a matter of fact the chemist without that practical training and experience to which I so strongly refer, has blocked and retarded the advance of the use of expert knowledge into the foundry trade more than any one other element.

He has industriously spent time and money analyzing for elements not in anyway entering the problem in hand and when obtained proving of interest but not of commercial value.

A good metallurgical engineer ought to accomplish with a given number of chemical results of his own selection twice the results that a first-class chemist could obtain; because of his practical training.

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Every analysis the metallurgist should ask for ought to count in getting at results. What a lot of good time and acid is wasted in determining the amount of graphitic carbon in pig iron for cupola work. The total carbon is the only vital carbon result worth consideration in connection with iron to be used for melting.

The amount of graphite is a measure of the time of cooling of the iron in which it exists. It depends on the initial heat of the molten iron; on the character of the mold in which it was cast; whether dry sand, wet sand or an iron mold, and on the volume of the casting. It may be varied at will by varied speeds of cooling and to conclude all carbon returns to the same conditions when melted, regardless of its condition when solid.

It is instructive in a finished product because it so strongly influences the physical characteristics of cast iron but valueless in pig iron for melting purposes.

I mention this as I know it to be one of the most marked examples of wasted effort in foundry chemistry. The iron agents dote on graphitic carbon. They would rather talk graphitic carbon to a prospective purchaser and thereby throw glamor and mystery over their iron than eat.

This is only one example of misdirected effort and by this and many others the chemist, pure and simple, has caused many foundrymen to condemn all chemical work and set all expert knowledge down as useless.

Another practice is having the same effect. The foundry manager who buys chemical results at a few cents each soon accumulates sheets of them; most are useless because he has not the necessary knowledge of metallurgy to get much out of them. Then he buys books on cupola practice; some of them good books, others inaccurate and misleading, at any rate contradictory. He is stuck and finally concludes the experts do not know anything anyway. Why? Because he has not employed a good one and because all that is printed in books is not gospel truth about foundry practice any more than about anything else.

One writer advocates physical tests only, another chemical tests only, another no tests at all and so on. As a matter of fact each kind of test is most instructive in its own particular field and an intelligent use of all kinds is the best practice. The thor-

oughly practical metallurgical engineer is the one that uses any one or all as the case demands and thereby gets the best results.

Now it has been thought that the small foundryman has less use for expert knowledge than the large one. I find the contrary to be true. Of the two the small producer is liable to the greater irregularities of product. The large buyer purchases in large shipments and either he analyzes every one and keeps them separate, thereby using them most intelligently or he throws them into large piles. The latter being the case then he uses from these large heaps not in the same order in which it was piled but instead in a different order, consequently getting an average from the pile for a day's melt.

This is like the making and eating of a layer cake. It is built up in horizontal and specialized layers and is eaten in vertical layers, each piece a good average of the whole.

In case there have been wide variations in the chemical character of the various shipments they will be hidden in the average, which will be about normal, certainly not bad enough to cause serious trouble at any time unless there has been a succession of bad shipments, the badness being all of one kind. This is not likely to occur and the large user is fairly safe. On the other hand the small buyer may have only a few car loads in the yard possibly of one kind and that kind way up in sulphur or all one way in some other bad respect. Not knowing it and without the advantage of averaging conditions the day's product may be very bad from his standpoint.

It is therefore plain that the small consumer needs more help in proportion to his tonnage than the large consumer. His cost charge for expert service will be greater per ton, all other things being equal, but not heavy even at that in consideration of possible benefits and savings and the small tonnage.

Assuming an engineer of metallurgical matters is employed, then to get the greatest benefit, the work must be systematized. Regular tests of product must be made often if changes are made in the mixture, and frequently, or at least in the event of the slightest irregularity of product. Not as often if changes are unfrequent or in case of very smooth running, but never less often than weekly so that a record may be preserved of good normal work as well as product out of the normal.

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Some one person at the works must make it part of his duty to follow up the correspondence with the metallurgical engineer. To report to the purchasing agent any invoice of iron that is not as good as ordered. The purchasing agent may then reject the iron if it is too bad to use at all or to offer to take it at a reduced price commensurate with its real value, if it is possible to use it somewhere. On the other hand if the iron is better than ordered (which often happens) then it may be laid aside to be used as an offset to some bad car load when the occasion arises. The same remarks apply to fuel and all other materials purchased.

It is certain that some one person must give it attention to gain the best results and also certain that much money over and above the charges of the engineer and chemist will be saved. But like any system such as cost or inventory if it is not followed up not only will there be no saving but there will be the loss of the original expense of introducing it.

It is not my intention to show the detail wherein an engineer may save his client but more to show his sphere of action. Examples are numerous and familiar to all those that have tried it with success and those that have tried it and failed certainly did not take advantage of opportunities.

Sentiment, rule of thumb methods, fancy prices for "special" irons and doses of medicine for a steady diet have to yield to facts, systematic methods, iron prices based on quality, and an open and above board cupola mixture with no mystery about it. Many may think such bad conditions as I have mentioned are back numbers, that they do not exist. I can state positively such conditions in the small foundry are the rule rather than the exception, and even in many large foundries where modern methods have not been heard of. Members of this Association can not remain so in the dark, but there are many foundries not represented in the Association as yet and there are many foundrymen that think if a pig iron bears a certain brand that it must be exactly like every pig with the same brand. They do not know that a given brand may vary between very wide limits and cause them as much variation as though they were working with several brands.

All this is no reflection on manager or chemist. In these days each has his own field of special training. One cannot know

everything and is fortunate if he does one small branch better than anyone else.

There is a feeling among many foundrymen that the employment of a Metallurgical Engineer will result in great friction with the iron dealers, because of the probable fussy demands of the engineer. I want to state an exactly opposite view. The intelligent engineer knows exactly what to ask for and exactly what may be had in the market at ordinary prices. He puts before his employer the simplest possible specification that will bring him the kind of pig iron he wants. The limits may be very wide and still give uniform castings for a product with intelligent mixing of several irons.

When such an iron is received by the foundry and is found to be within the reasonable limits specified, then there can be no more question between buyer and seller. The responsibility rests on the engineer who specified it.

On the other hand a very confused state of affairs is often found. The foundryman orders Excelsior brand No. 1 pig iron like the last he had. It arrives and the first day he puts it into his cupola he may get a lot of dirty castings or something else abnormal. He does the natural and obvious thing on the face of it, and lays the trouble to this new shipment of pig iron in the absence of accurate information. He then promptly writes a letter of protest to the furnisher of the iron and perhaps refuses to take it if the difficulty has been a very serious one. Then follows a long dispute, further trials of the iron, dissatisfaction between buyer and seller and after all it may never have been the iron in question that caused the trouble. This is not a coincidence that has come once under my observation but many times and is the result of a great deal of friction.

What few remarks I have heard made by iron dealers have been favorable to the intelligent and practical metallurgical engineer. If they furnish what they are asked to furnish they know they will be paid for it.

On the other hand an inexperienced engineer, not familiar with the manufacture of pig irons and the conditions affecting its quality may demand unreasonable composition and quality. Then there is sure to be friction and cause for just complaint on the part of the seller.

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EMPLOYER AND EMPLOYEE.

BY S. H. STUPAKOFF, PITTSBURG, PA.

The span of time allotted us here is practically but a race after the means to make life worth living. Pleasant surroundings, cheerful companions, healthful conditions, liberal treatment, and remunerative occupation are the sign bearers of well being. Such a state of affairs should make every man happy and content, and it should cultivate a cheerful and satisfied temperament in mankind. Wherever this fails of accomplishment, an unhealthy condition prevails under which the mind and the body suffer and decay. Both require watchful nursing, careful attention, and persistent training to keep them in the normal channels.

Differences of opinion culminating in labor troubles see in the employer the oppressor, and in the laborer the slave. This should not be so. The laborer has no just cause to complain of his own fate, and envy the position of his employer. There is little left to envy if all the trials of the employer are thrown into the balance. The inner life of the employer is like a closed book, while that of the laborer is like a placard. There would be less antagonism on the part of workingmen if these conditions could be reversed.

Let the fair minded man remember that the most successful men of all times rose from his own ranks, and that he has the same chance. If he be ambitious, let him strive for the same goal; if apt and deserving, his services will be in demand and rewarded in a substantial manner. If he has executive ability, he will be given more and more responsibility. Men of this stamp are always in demand, are eagerly sought for, and fill the best positions with the highest compensation. The limit of advance-

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ment for the capable man is only at the top of the ladder.

These views may not accord with the communistic ideas of the majority of our modern labor organizations, but they are the natural deductions of the law of evolution, and certainly represent the feelings of the employer.

Employers are as a rule broad minded enough to give full return for value received. They however, object to paying inferior men, who may be no more valuable than laborers, the same wages they do their best mechanics. Labor unions deny them the right to discriminate, they insist that it must be left to them to determine the rate of pay, and to select and place the men in all positions. They object at the discharge of members of their organizations, and in many other ways attempt to meddle with the management of even the best regulated institutions. This is a source of constant annoyance to the employer, and the cause of the continuous warfare between capital and labor.

According to the rules of modern labor organizations, their members are under practically no obligations to their employers. They may leave any time they choose to, but must not be discharged without the consent of the union. They must be paid a stated amount of wages, but are not compelled to do a stated amount of work. They must receive their pay in full at regular intervals, but are not compelled to render full services during the regular working hours. They may commence and leave off work when they please, but must not be laid off when it so suits the employer. They must receive an advance in pay for all time worked over the regular hours, but are not to be asked to furnish more work in return.

This would seem sufficient proof that the working man is relieved of all obligations, beyond those to his organization, and his family. Surely we may now believe that "In union is strength," though even Shakespeare has it "Oh, it is excellent to have a giant's strength, but it is tyrannous to use it as a giant."

Now how about the obligations of the employer. He has them to his customers and to his creditors, to his associates and to his community, to his employees and to his conscience, to his city and his state, to his country and to the world at large. His success depends upon his judgment and executive ability, skill and forethought, shrewdness and honesty, activity and firmness,

promtitude and reliability, trustworthiness and respectability, and finally to the faculty of adapting himself to all conditions, and ability to master all emergencies. His actions must be above criticism, his intentions beyond suspicion, his dealings fair, his word beyond doubt, his transactions open to inspection, his obligations binding morally, even without promise or contract.

Just contrast these conditions, and you will confess that the employer has to carry the heavier burden by far—too heavy indeed for the shoulders of the workingman. And for this burden the employer should find due compensation. This with all fairness to the employee, and all effort to contribute to his well being.

Now let the workingman also do justice to his employer. Let him attend strictly to his duties while at work, let him do the very best he can in quality and amount of work, let him take pride in it, and let him realize that his time belongs to his employer. The workingman is no less bound to do his full duty as is his employer in turn bound to look after the interests of his men. Let the workingman be loyal. His employer pays for skill rendered; he pays for the time during which such skill is rendered him for his sole benefit. He buys it, and it belongs to him.

Men in business make their living by buying and selling commodities. He who can buy lowest and sell highest has the most profit. But the price of the goods is always regulated by market conditions. Supply and demand regulate values. Goods will not bring higher prices than they can be bought for elsewhere in the open market. Every business man has to face competition, and in selling must meet the prices of his competitors. All manufacturers are business men, but they are not only trading. They are producing commodities from raw materials. The raw materials of one factory may be the finished products of another. An article of commerce usually takes several operations, and passes through very many hands before it may be finally marketed. No manufacturer can succeed unless able to produce articles of superior quality and reasonable price within the limits of quotations in the open market. He may therefore only select the best and most reasonable raw materials and labor. He has the right to accept and reject material, to dispose of his

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product as he sees fit. He has the right to engage whom he will in this production, and has the right to discharge whom he can or will spare.

The employer should recognize the wants of his men, should make them feel comfortable and at home, grant and give them what is their due. He must understand how to keep his men in good spirits, and yet maintain for himself their respect and esteem. The workingman, on the other hand, should acknowledge the benefits bestowed upon him by a considerate employer, and should aid him in his efforts. He should look upon work as a pastime, on exertion as sport, achievements a boon, and employment a pleasure.

There should be a relationship established based upon esteem, friendly intercourse, righteousness and humane views. Under these conditions there will be a bountiful harvest for each and everyone affected. He who toils all day will then enjoy his evenings in good temper and with contented mind.

No man of sense will contend that it is just to demand equal pay for all work, good or bad, much or little, if the work which is thus produced cannot be similarly disposed of. It may be necessary for the employer to submit temporarily to such unsavory conditions, but perverted ideas of this kind cannot exist for ever.

Social life is but a "Give and Take," not "Your Money or Your Life;" and all parties fare best if they remember in their dealings with each other the "Golden Rule," which is just as applicable to our industrial life as it is to every other condition.

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VOL. XII. JUNE, 1903. PART I.

FOUNDRY MANAGEMENT.

BY DAVID SPENCE, CHICAGO, ILL.

If a foundry foreman desires to keep his shop force up to a high state of efficiency he will, as soon as he receives an order for castings, see that the necessary cores are at once ordered from the core department. Then he will proceed to learn if he has a suitable flask for the casting, and if he has, he will ascertain if any repair work is needed on this, and if so, he will have this done before the flask is taken to the molders floor. All repairing of flasks should be done by a flask man instead of the molder and his helper. In order that the molder may use his time to the best advantage his helper should see that he not only has facing sand, gaggers clamps, etc., but he should also look after the many little things which the molder sometimes spends his high priced time in looking up. Even in specialty shops I have seen molders take a hand in barring up flasks. This they should not have to do, as this kind of labor belongs to the flask maker, and the latter will do a better job than the molder every time.

In a great many foundries the men depend too much upon the foreman for everything. They should remember that he is only human, and has not the time to attend to every little detail. It has always seemed strange to me too that the place where casting are made should receive so little attention from the owners of plants, a majority of whom seem to believe that anything can be made to do for this department. Perhaps nearly every practical foreman is familiar with shops where ordinary equipment is so scarce that the molders are spending a great part of their time looking for things of which each should have a plentiful supply. The successful foundry manager of to-day must not only be practical molder, but also experienced in cupola practice or he is not fully qualified for the

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position. Of course he should be a man of good judgement, cool and pleasant, and while he should treat his men in a liberal way, he should not be backward about taking a firm position whenever this becomes necessary.

A competent foundry manager is worth a good salary and is sadly needed by many foundries who are attempting to direct shop affairs from the office through men of small experience who are really not foremen at all. At the present time we have another drawback in our foundries in the form of incompetent pattern making. I have seen patterns come into a foundry made solid, where they should be split, and blank gears with hubs nailed on where these should be left loose. Again the foundry manager has his hands full to handle the traveling class of molders who generally come into a shop without a tool and whenever they are ready to draw a pattern they will look around for a nail to drive into it, and then break a clamp in two so that they may have a substitute for a hammer.

Naturally the successful foundry manager will watch the little things and guard against waste as much as possible. A few years ago I took hold of a foundry where I found thirty tons of iron in the form of scrap buried in the ground. I at once had this dug up and dried and put through the rattler, when I used a few hundred pounds a day until it was all used up. Whenever owners of a foundry have a good foreman they should treat him right and give him to understand that they have confidence in him. When they furnish him what he requires to work with in the way of material and equipment then, and not until then, have they got a right to look to him for results. There are to-day too many men acting in the capacity of superintendents of plants who should be flask men and I have seen many a foreman who was more competent to be superintendent than the one who was placed over him. The young men of abilty should be encouraged and promoted in every way, as it is to them we must look for foundry managers in the future.

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NOTE ON CONTINUOUS MOLDING

BY EDWARD RICHELIEU, SOUTH TACOMA, WASH.

I was very much interested in the recent paper of Dr. Moldenke in which he discusses the eight hour day, calling it a good move on the part of the foundry, provided there were three of these days in the twenty-four hours. This recalls my experience in a London shop in which I spent a number of years. Here everything was ready to start molding at once, and nothing was required of the molders but mold. Helpers weighed the flasks, had the fires ready for skin drying, and kept pace with molders to the completion of the mold. Where shank-ladle work was made, the iron was brought to the floor, and if the helper was trusted, he was told to pour. As a rule the helpers were trusted with almost everything in this jobbing shop, and it left the molders to devote practically all their time to molding

Good rigs were provided, and the molders were well satisfied and put up a good day's work. It was not necessary to go around the shop to give lifts, for enough help was provided for the purpose.

In connection with continuous work, I will cite an instance where not only work in quantity was produced, but a great saving in flasks and patterns was effected. The job was making 4" pipe. Ten flasks and one pattern only were provided. Three molders in one gang molded up thirty pipes by piece work. Then a gang of three more men came on and made thirty more pipes, and finally the last three men came on and finished up the ninety for the day's work of 24 hours. Which shows what can be accomplished in the way of continuous production with a minimum of eqnipment.

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THE MOLDING MACHINE.

BY S. H. STUPAKOFF, PITTSBURG, PA.

GENERAL CHARACTERISTICS.

The object of machine molding is to save labor, to increase the output of a foundry, to decrease the cost of production, to produce uniform and, if possible, better castings than can be produced by hand, and to employ the smallest possible amount of skill in those particular molding operations, which comprise a series of ever repeated automatonous movements.

It is obvious, that it would require a complicated mechanism to perform successively and successfully all the necessary operations to make a complete mold, even if it were only the mold of a simple pattern. And, in consequence, the general equipment of a foundry, which accomplishes this object, must be necessarily quite an elaborate and expensive matter. The majority of designs of molding machines run in this direction, whereas, in most cases it would have been better if the energy expended had been directed to their simplification. Such tendencies lead to complications, which are altogether unsuited for foundry practice; they meet with little favor and machines built upon these principles are of short life. Only the simpler molding machines have a chance of meeting with more or less success, even if they perform but a few operations, providing they perform these well. Many founders would be well satisfied if at least some of the more expensive operations could be performed satisfactorily with the aid of time saving machinery. With this object in view, some ingenious founder or molder originally devised a contrivance to withdraw his patterns from the mold by mechanical means. Accessible records show that this occurred at least during the first half of the last century. The next step was to employ stripping plates, and conjunctively therewith it was attempted to ram the mold by machinery. These two operations, i. e. withdrawing the patterns from the sand, and ramming the flask, are the basic

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principles of all molding machines. Some machines are constructed to perform the one, some to perform the other operation and still others combine both in the same apparatus. All subsequent improvements and additions, and all variations and methods of construction are merely a matter of detail. However, it must be said that it is solely due to the judicious selection and arrangement of the very details, and to the superior refinement and quality of workmanship employed in their construction, that modern molding machines have actually become a success.

It would be idle to enter into a detailed description of the long series of schemes which have been suggested, and which have been patented in this and in other countries. Some of them seem quite feasible and some of them have been successfully put in operation; but the majority are more or less impracticable and not worth the effort expended thereon. In the following only the type of each group will therefore be presented, and occassionally a description of the more important parts will be given; but we shall dwell at length upon the construction of those machines which have found favor with our foundrymen, and which, be it through merit or push, have found introduction and gained a strong foothold in many of our modern foundries.

CLASSIFICATION.

A systematic chart, such as follows, giving in a condensed manner the entire scope of the history and of past and present achievements of molding operations, and molding machinery will serve as the best means of representing this art in all its stages. It needs little or no explanation. An examination of its contents will show not only the functions of each individual class of machines, but it will also explain the gradual development and the relationship of the various contrivances. It may also aid to acquaint the reader with the extensive field of this branch of the industries, and, incidentally, it may enable him to form a fair idea of its future possibilities.

We observe from the accompanying chart that molding machines may be divided into two large groups according to the manner in which they are operated, that is in hand and in power machinery. The former may be made stationary or portable;

each class being adapted to the peculiarities of existing conditions and requirements. Stationary machines may be distributed to good advantage along the walls or in rows along the aisles of a molding floor; quite frequently they may be secured to benches or posts or to the walls of the foundry. In other instances they may be advantageously provided with individual stands. The selection from these arrangements depends mostly upon specific circumstances, and little can be said against or in favor of one method or the other. Portable machines may represent the identical details of construction in their mechanism as stationary machines, but they are always provided with individual stands on wheels, which admits of their being easily rolled from place to place, following the sand heap and the flask pile on the foundry floor, and leaving the finished molds behind them.

A good object lesson of the advantage of moveable molding machines was given in a pamphlet by Mr. Henry E. Pridmore, wherein he explained that "for filling a foundry floor with 270 12"x28"x8" flasks by working either at the bench or with stationary molding machines, two molders would have to walk 7 miles and 720 feet, carrying a heavy flask over half the distance; while, with the proper arrangement and with movable machine this distance was reduced to 6480 feet or to about 1-5 of the above journey."

It is interesting to note that the quantity of molding sand alone in this case represented a mass equal in weight to about 20 tons, which remained practically at the same spot where used, while in bench molding or with stationary machines it would have to be carried over the given distance twice, that is, once from the floor to the bench before molding and once from the bench to the floor after molding.

This sounds like a strong argument in favor of portable molding machines. But, let us sift the ground before we jump to conclusions. If the question were asked: "Are portable machines always applicable?" we must answer decidedly "No." In that case there remains nothing for us to do, but to imitate Mahomed and go for the sand pile, if the sand pile will not come to us.

Portable machines are good in their place, but they are not good in all places. Molding machines can be made portable only

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in such cases where they are operated manually, and economy by portability decreases as the size and weight of the machine increases. Machines driven by power depend more or less upon fixed positions, and cannot be moved about. It is of course an object well worthy of careful consideration in all cases to save time and labor in handling the molding sand, the flasks and the finished molds; but other means than portability on the part of the molding machines must usually be resorted to, to attain the desired results. We may find an opportunity to discuss them in one of the succeeding chapters.

HAND PRESSES.

The simplest form of all molding machines is undoubtedly the "squeezer." As its name implies, it serves the purpose of "squeezing"—not ramming—the molding sand into the flask. This object is accomplished by applying pressure to a plunger which is provided with a suitable press board, and compacting the sand in the flask by this operation. Properly speaking it is therefor a "Plunger Press," or a "Plunger Molding Press."

The flask with follow or molding board and patterns is usually placed on a platen or table, and either the plunger is moved downward or the platen with the flask is moved upward. In exceptional cases the plunger or plungers move horizontally. Either one of these arrangements accomplishes the end, but satisfactory results depend largely upon the details of construction of the respective machines.

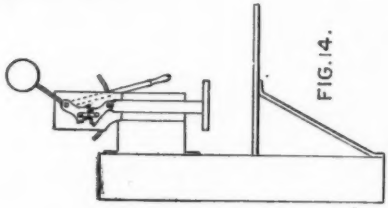
In most cases the pressure is applied by compound leverage, which, as a rule, admits of the simplest and most effective design. The moving portions of such machines, which are continuously exposed to the erosive action of the molding sand, and which, on this account, are subject to considerable friction and much wear, may therefore be made exclusively of pin connections. These are less expensive, and when worn easier replaced, than the parts of any other mechanical movement.

HAND PRESSES WITH OVERHEAD MECHANISM.

The most effective squeezer is one with the most powerful and most sensitive leverage, which requires little muscular effort and which confines the movements of the operator within a small

compass. It appears further, that it would be of best advantage to arrange all moving parts of a molding machine above the flask, as in this manner they will be removed from the direct influence of the sand. Such an arrangement would give little opportunity for wear and tear, few interruptions in service, and a minimum of repairs.

This principle was followed in the construction of the post press, illustrated in figure 14, wherein the entire mechanism is arranged above the flask.



The leverage here consists of a toggle joint which is operated by toothed eccentric segments. One of these segments forms an integral part of the combination counterweight and hand lever, and the second one is pivoted to the head of the plunger, which carries the press board at its lower end. Both segments are connected by a double link, which not only keeps the teeth of the segments in proper mesh, but which at the same time serves as a member of a toggle joint, of which the arm of the lower movable segment is the second member. The eccentrical arrangement of the gear segments imparts a quick movement to the plunger at the upper period of its stroke and multiplies the power applied at its lower period.

The mechanism is well designed, and comprises but few parts for the purpose it accomplishes. But it seems that the length of the stroke, depending upon the nature of this construction, is rather limited, and it is questionable whether the moving portions in spite of their dust proof covering are not subjected to the cutting action of unavoidable dust. This machine, as found in the market, is either secured to a stationary post, and in this case it is provided with a bracketed shelf below the plunger head, which serves as a support for the bottom or mold board and flask (Fig. 14); or it is mounted on a movable frame as illustrated in Fig. 16.

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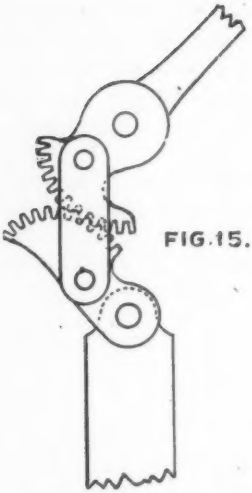


FIG. 15.

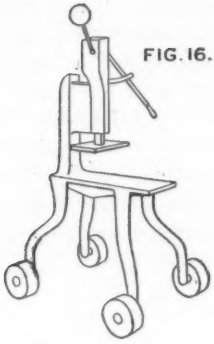


FIG. 16.

Some of the various mechanical principles which have been suggested for hand presses of the same class are illustrated in figures 17 to 25. It will be observed that these sketches represent exclusively hand squeezers with overhead mechanism. Though but few of them possess real practical merit as a whole or in detail, they will serve to picture the various attempts which have been made to apply nearly all the simpler mechanical principles for the same purpose.

The screw, the rack and pinion, the eccentric, the crankshaft, the cam, the single and the double toggle joint and the compound lever are herein represented. All are connected or form part of a rod or plunger which carries a presser board at its lower extremity, and all serve for the purpose of depressing this

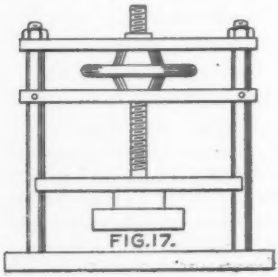


FIG. 17.

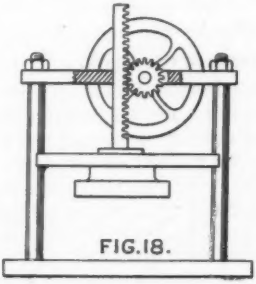


FIG. 18.

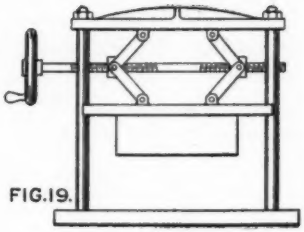


FIG.19.

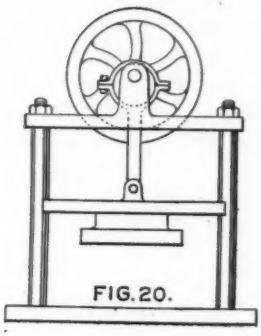


FIG.20.

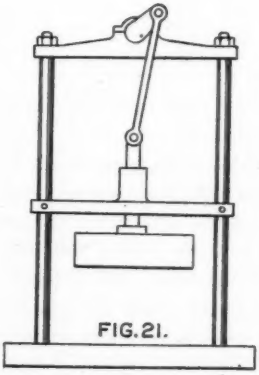


FIG.21.

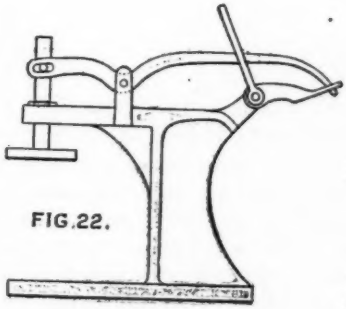


FIG.22.

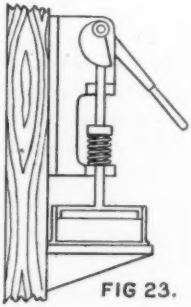


FIG 23.

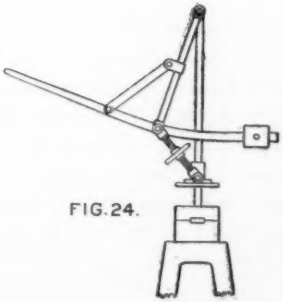


FIG.24.

plunger and for compressing the molding sand in the flask with the presser board.

It is an easy matter to see the shortcomings of these devices; it is most important that a hand press of this class should combine with simplicity of construction, powerful leverage, quick action, adjustability and accessibility, that the moving

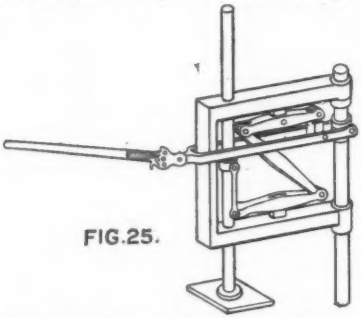


FIG.25.

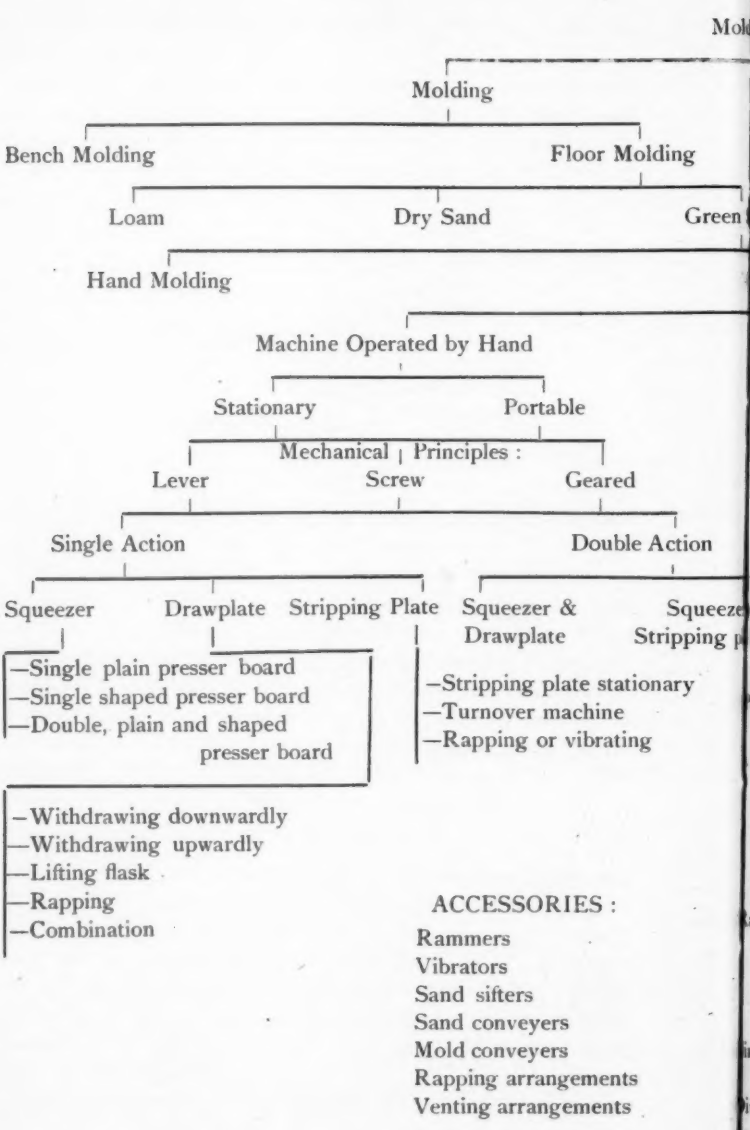
parts should be subject to little wear, and that sand and dust should add but little to the frictional resistance.

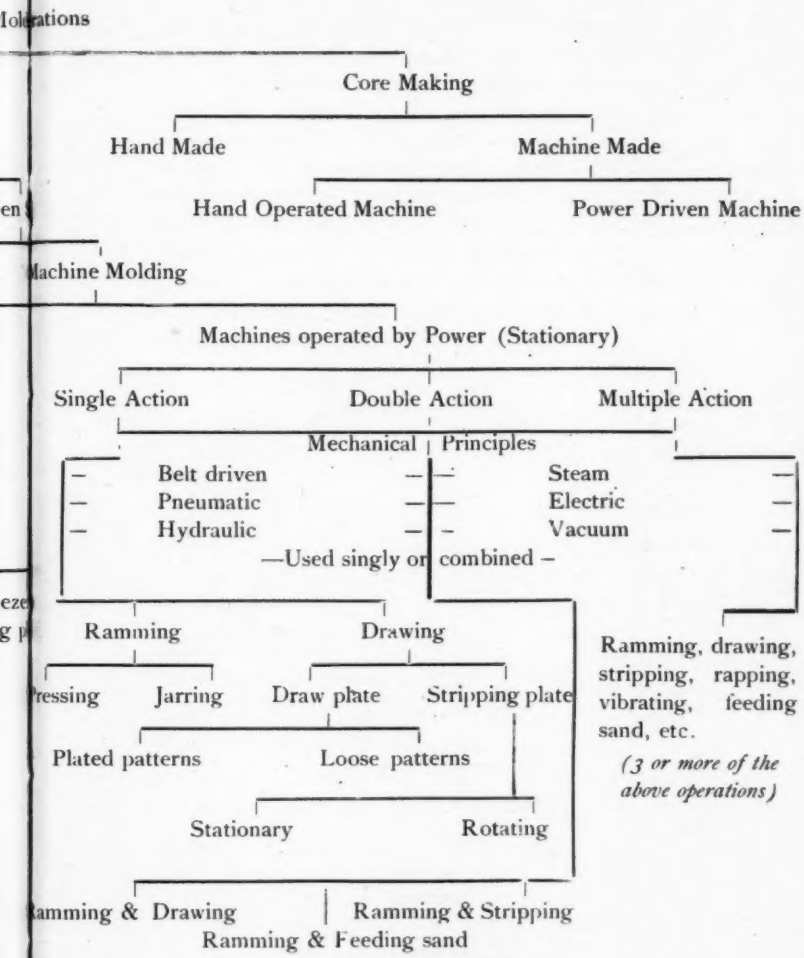
These illustrations will have fully served their purpose, if they do nothing else than point out objectionable features, and possibly guard against the mistake of selecting and embodying unsuitable principles in the design and construction of foundry machinery. It may be added that if anybody should take a fancy to any one of the above designs (Fig. 17 to 22), they may do so without fear of infringing the rights of others, as these represent patented devices for which the government protection has expired.

Hand Presses with underlying Mechanism.

A second group of plain hand presses embraces all machines which have their mechanism arranged below the table, or respectively the flask. We meet here with numerous designs, which embody almost without exception the application of compound levers. Molding machines belonging to this class are operated in three different ways, namely: by forcing the pressure head downward, or by forcing the mold upward, or by moving both portions toward each other.

Economical reasons prescribe, that the pressure head should


Molding
Bench Molding
Floor Molding
Loam
Dry Sand
Green
Hand Molding
Machine Operated by Hand
Stationary
Portable
Mechanical Principles :
Lever
Screw
Geared
Single Action
Double Action
Squeezer
Drawplate
Stripping Plate
Squeezer & Drawplate
—Single plain presser board
—Single shaped presser board
—Double, plain and shaped presser board
—Stripping plate stationary
—Turnover machine
—Rapping or vibrating
—Withdrawing downwardly
—Withdrawing upwardly
—Lifting flask
—Rapping
—Combination
ACCESSORIES :
Rammers
Vibrators
Sand sifters
Sand conveyers
Mold conveyers
Rapping arrangements
Venting arrangements



COMBINATION MACHINES :

Special molding machine—(Pulley, brake shoe, journal bed, etc.)
ingle & double flask, Turnover machines, Revolving table machines,
Truck table machines, Universal molding machines,
ividing head molding machines (gear molding). Automatic molding machine.

only occupy its central position with regard to the position of the flask on the machine table during the performance of its function. At all other times it would act as an obstruction and it should be taken out of the way during the placing of the flask on the machine, the filling of the same with molding sand, and its removal after completion of the mold. This is accomplished by either pivoting the pressure head uprights to the base of the machine, or by swinging the head horizontally in journals around a vertical post, or by sliding the table or the pressure head in guides in a straight line in one direction or the other. These three principles are illustrated in figures 26, 27 and 28, which require no further explanation.

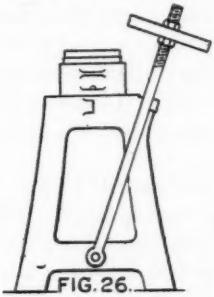


FIG. 26.

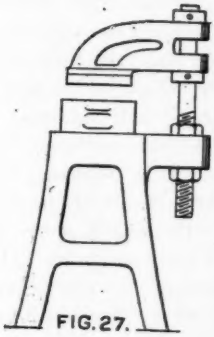


FIG. 27.

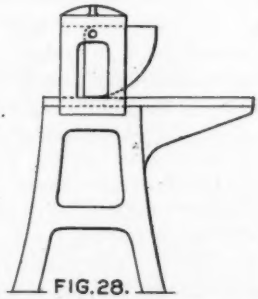


FIG. 28.

This movement ordinarily requires a special manipulation by the operator, which is not seriously objectionable, especially if the head is counterbalanced, be it by weights or by springs. The designers of some machines prefer to accomplish this movement by means of the main hand lever, which perform the act

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of pressing. And naturally, by doing it in this manner, it can be done only at the expense of the length of the stroke, which is hereby in some cases quite unduly increased. It is quite an important matter in hand operated machines, that the length of the stroke of the main lever be kept within as small a compass as possible.. By increasing it the bodily exertion of the operator will be increased likewise, and the output or the capacity of the machines will suffer materially.

Particular attention of designers, manufacturers or purchasers of such machines is directed to the importance of confining the motions of the operator within the smallest possible limits. He should remain permanently in an upright position, he should have no occasion to stoop or to excessively bend his body; he should be able to perform the bulk of his work by using only the muscles of his arms, adding thereto occassionally the weight of his body, if this should be necessary. If these rules are strictly followed, it is reasonable to suppose that the best possible results can be expected.

It is necessary that the distance of the pressure head from the table should be made variable, that it may accommodate itself to the height of the flask, which varies with the particular piece of work on hand. This is easiest accomplished by means of adjusting nuts placed on the uprights above and below the pressure head, as shown in figure 26 or by raising and lowering the pressure head column in machines of a design as Fig 27. Makeshifts, obtained by piling up additional boards on top of the pressure board, which practice is frequently resorted to, require too much handling, and are costly, uneconomical and unadvisable.

Machines with Movable Table.

Figures 29 to 32 illustrate several types of levers applied to hand presses with underlying mechanism, which are operated by raising the table with the flask, in this manner forcing it against the vertically fixed pressure head. The drawings at the same time illustrate different modes of guiding the table in its support. The position of the pressure heads is indicated by dotted lines. Figure 29 shows the positions of the mechanism in its normal position in full lines and in its reversed position in dotted lines. The drawings in which all details have been purposely omitted, are self explanatory; their object is to particularly show the man-

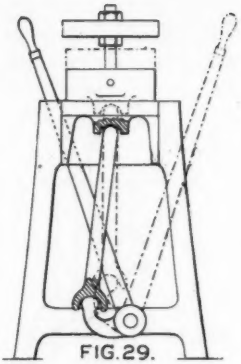

FIG.29.

FIG.30.

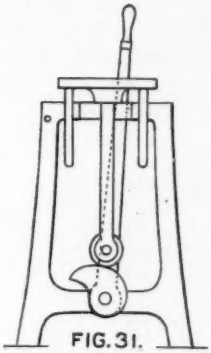

FIG.31.

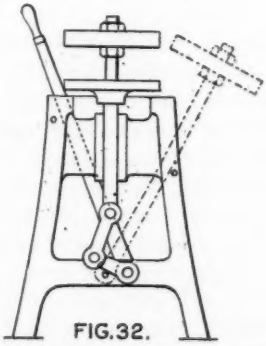

FIG.32.

ner of raising the table and flask by the reversal of the upwardly extending hand lever, which is directly connected to a shaft that carries either cranks, levers, cams, eccentrics, pinions or any other suitable contrivance which engage with the downwardly extending shaft or stem, or shafts or stems, of the table.

MACHINES WITH MOVABLE PRESSURE HEAD.

A second principle for applying pressure to the mold in plain hand presses is illustrated in figures 33 and 34, which show the usual method employed for pulling the head downward against the mold.

The pressure head uprights are in this case preferably arranged as in the foregoing, that they may be swung backward, and for this purpose their lower ends terminate in eyes which

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are movably fitted to pins. These pins, studs or shafts are arranged to slide vertically in slots or guides of the frames or standards, and they are either directly or indirectly connected to

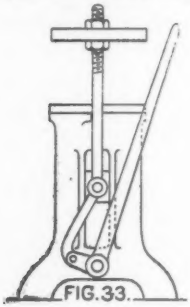

FIG.33.

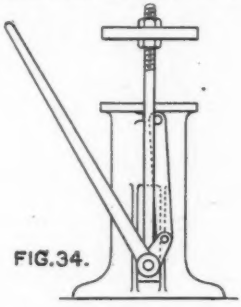

FIG.34.

a hand lever. The normal position of the latter is towards the rear of the machine, and the upward or raised position of the pressure head corresponds with it, while its reversal causes a downward movement of the head and upon application of muscular force a corresponding pressure upon the mold.

It will be observed that the arms of the knee lever in figure 33 swing around a fixed center, which forms part of the frame work, and that in this case the end of the shorter arm is connected by a link to the base joint of the pressure frame, while in figure 34 the end of its shorter arm is jointed to a movable link, which is journaled at its upper end to the frame, whereas the boring at the apex of the angle engages directly with the pin of the pressure frame.

Other means are employed to accomplish the same results and to take the place of those which have here been shown and described, but they are mostly even more complicated and offer no additional advantage. As it is impossible to show everything in a paper as the one now before you, it is hoped that the instances which have been cited, may be accepted as a sufficient demonstration of the present case. More over there will be opportunities later on to show and to describe further mechanical movements in connection with other types of molding machines, which are applicable with equally good or bad results to those of simpler construction.

MACHINES WITH DOUBLE FUNCTION HAND LEVERS.

We will now turn our attention to figures 35, 36 and 37, which show the combination lever movements of a well known

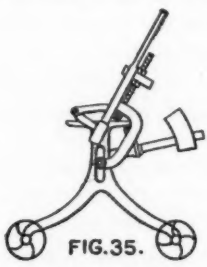

FIG.35.

FIG.36.

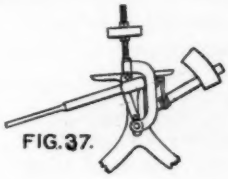

FIG.37.

molding machine which combine the forward movement of the pressure head with its downward movement towards the mold. The arrangement of levers varies but little from those shown and described in the foregoing, but by securing the fulcrum of the hand lever above the fulcrum of the vertically movable pressure head uprights, and connecting its short angular arm to a link which engages with the uprights above the two mentioned fulcrums, an additional function of the leverage is attained. This acts so that the first portion of the stroke of the hand lever swings the pressure head forward and in this manner brings it into a vertical position against a stop. A further movement causes it to descend vertically toward the table of the machine. A counterweight, acting upon a crank-like bent shaft which is secured to the lower fulcrum of the pressure head uprights assists in raising the head when the lever is reversed, and in bringing it back to its normal position.

It is an unlucky coincidence that with this arangement at the very moment when the greatest power is required for compressing the sand, a part of it is spent to raise the counterweight to its uppermost position. This, however, is partly offset by the fact, that at the end of this portion of the stroke the lever is in the most favorable position for the application of pressure, as the operator may use the maximum stress of his arm muscles, and add his own full weight to effect its depression. On the other hand again, it should be noted, that nearly 90 degrees or two-thirds of the entire stroke of the hand lever is required to

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bring the pressure head from the rear to its central position; and this is a proceeding which does not deserve particular recommendation. On the whole, however, it must be said, that the combination of this leverage is an economical arrangement, which accomplishes its purpose without the expenditure of much power, and causes but little inconvenience and fatigue to the operator.

Figures 38 and 39 illustrate the leverage of another style of hand press which accomplish the object just described, but in a different manner.

The hand lever of this machine is arranged independently from the pressure head uprights; both swing in independent centers; the hand lever engages with these uprights indirectly, by the interposition of supplementary levers, and such engagement continues only during the first portion of its stroke; it disengages after it has brought the pressure head from its normal into the vertical position; the pressure head is stationary with relation to the flask, while the table with the flask moves upward toward the pressure head, all of which is contrary to the arrangement as described in the foregoing. The supplementary levers are two-armed; they are secured to the machine frame by studs which serve as their fulcrums. The end of one arm of each of

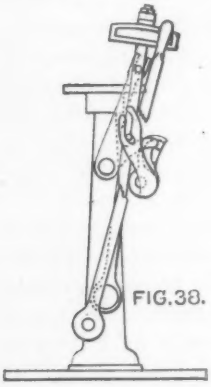

FIG.38.

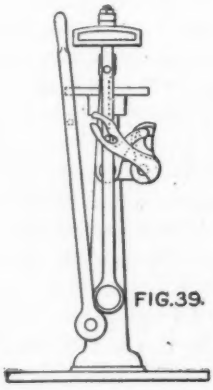

FIG.39.

these levers is slotted or fork shaped, and fixed studs or pins, placed in corresponding positions in the hand lever and in the adjoining pressure head rod enter the slots. The second pair of

arms of these levers are provided with a stud in one, and a cam shaped groove in the other. Both are linked together by these means, and their relative position governs the position of the pressure head. The normal state of things is illustrated in figure 38, which shows the machine at rest, and the reversed state, showing the position of the levers, after pressure has been applied is given in figure 39. It will be observed that the engagement stud of the hand lever enters the open end of the slot in the fork-shaped cam lever during its backward movement, and in following the curve of this slot it causes the pressure head upright to be forced backward. The hand lever engagement stud will rest at the lower end of the cam lever slot, and the table and flask will have returned to their original position of rest, when the pressure head arrives at its final inclined position.

OBJECTIONABLE FEATURES.

A close scrutiny of the merits and demerits of this arrangement cannot fail to reveal the fact, that the moving parts of this machine are too much exposed to the injurious action of spilled sand, and there is no possible way of effectually guarding against it. The slots and the groove in the cam have sliding faces, which are exposed, and which must be exposed to admit of a free ingress and egress of the engaging studs, and all these are open to the free access of dust and molding sand.

A combination of the mechanical movements of the main lever and the pressure head may appear at first sight as a preferable and superior arrangement. The simultaneous or connectedly consecutive movements of both, however, offer but little advantage in general. And, should it be the case, that the inappreciable gain be offset by other objectionable features, as by the troublesome task which arises from the compulsory frequent cleaning of moving parts, and from subjecting these to excessive wear and tear, it would seem better and cheaper in the end to adhere to the simpler constructions, and move each portion separately and independently from the other.

These remarks should not be construed prejudicially against any particular construction, they merely express an impartial view of the subject, which is based solely upon facts and close observation. They may serve to throw light at some of the faults which are usually encountered in all molding machines, and they refer with equal force to designs as illustrated in figures 35 to 37, where exposed slots in the frame act as guides for the vertical movement of the pressure head. Though, in this particular case, a close fit is not very important, the necessary precaution should have been taken to prevent an accumulation of molding sand about the sliding portions as well as at the bottom of the slots.

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SCOPE OF PLAIN HAND PRESSES.

It requires very little reasoning to prove that the scope of utility of the described forms of "squeezers" encompasses but small limits, and that their successful application is strictly confined to the molding of shallow patterns. Unless in the case of deep patterns, ordinary hand ramming and peining, is resorted to at least for a part of the operation of compacting the sand, the simple manipulation of the flat bottom pressure head will give but a poorly packed mold, which cannot possibly result in satisfactory castings. It is liable to give rise to all sorts of trouble. The casting may not come out true to size or true to pattern; it may be swelled and rough in one place and not run full in another; the molding sand which has not been rammed sufficiently hard in places may be washed off by melted metal, and as a consequence the casting may come out dirty and be unfit for use. Many other objectionable features may result, which would condemn not only the casting but also the molding machine itself.

It is well known that patterns of different characters require different treatment at the hands of the molder, and that it takes the combination of good judgment and skill only to be acquired by long practice, to make molds of various intricate shaped patterns which will always produce good castings.

It is a grievous mistake to think that a molding machine of any description will replace a skilled molder. There is no less ingenuity required to produce good castings on a machine than to make them by hand. A molder is aided by his experience and by his good judgment; a machine hand (customarily selected from unskilled labor) has nothing to offer but his muscles and his good will. These qualities, however valuable they may be in some places, are at best but poor substitutes for the dexterity of an expert. This being the case, it is quite natural, that under ordinary circumstances the chances are but slight to obtain good castings and good general results by mechanical means which are imperfectly understood, and subjected to reckless abuse by hands which are unquestionable green in the business. And, if it were for no other purpose than to avoid loss and failure, this should be sufficient reason to provide if possible the necessary means to counterbalance all, and where this cannot be accomplished at least the greater part of the shortcomings of this method. Owners of molding machines should not expect marvels from an inert piece of mechanism; but it is safe to say they will seldom fail in their calculations, if they are satisfied with a reasonable increased production, provided they are willing to pay the best possible attention to their manipulation.

Journal of the American Foundrymen's Association.

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BLAST FURNACE CONDITIONS AFFECTING THE CHEMICAL COMPOSITION OF FOUNDRY IRON.

BY W. WALLEY DAVIS, ROANOKE, VA.

So much has been written about the phenomena of the blast furnace, and the investigations of the reactions taking place in it have developed so many data of positive knowledge that it seems superfluous to attempt to touch upon it further, except to record results of a special investigation. It is not the purpose of this paper to attempt to set forth anything novel or original, but to define as clearly and simply as possible some of the usual blast furnace conditions that contribute to or directly cause changes in the chemical composition of the product. As greater attention is now being paid to the chemical analysis of foundry irons by the consumers thereof, it is important that the latter should have an understanding of some of the difficulties surrounding the manufacture of pig iron, and more particularly the difficulties of producing an iron of uniform analysis.

The elements of an operating blast furnace are for the most part variables, all of them influencing its working and the character of the iron produced. While it is possible to manipulate these variables so that a fair uniformity of results is obtained, there are certain combinations that occur frequently which compel a departure from uniformity, and make impossible an immediate return thereto. The chemical reactions that take place are progressive and continuous, and any condition that occurs to interrupt or modify the progression materially affects the ultimate result. If we consider for a moment the changes that take place in the conversion of ore into pig iron, we would the more readily appreciate the delicacy of the process and the ease with which the latter may be modified. The materials ordinarily charged into a furnace are coke, ore and limestone in the order named. While these materials at first assume distinct strata they do not descend into the furnace in this manner, but gradually distribute themselves in various forms according to the manner of charging. The iron ore at first suffers no chemical change, but it grad-

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ually absorbs heat until it begins to part with some of its oxygen, which immediately reacts with the carbon monoxide of the ascending gases to form dioxide. The carbon monoxide of the ascending gases next doubly reacts on the iron oxide of the iron, producing carbon dioxide and a lower oxide of iron on the one hand, and carbon dioxide, metallic iron and free carbon on the other. The first of these reactions continues until the reduction of $Fe^2 O^3$ to $Fe^3 O^4$ is complete. The free carbon liberated and deposited reacts also on the original oxide to form metallic iron and carbon monoxide, but this metallic iron reacts with carbon dioxide to form ferrous oxide (FeO) and carbon monoxide. The last reactions taking place are the conversion of the iron oxides into metallic iron by the action of carbon and carbon monoxide, and the decomposition of the limestone into lime and carbonic acid. All these reactions depend upon temperature and the composition of the gases. While the interchange of the elements occasions many complexities, there is a certain elasticity about the process that makes possible considerable variation without disastrous results. Considered simply, the reduction of iron oxide to metallic iron is effected by carbon and carbon monoxide. The air of the blast furnishes the oxygen which is converted into carbon dioxide and almost immediately into carbon monoxide by the incandescent coke, and this performs the bulk of the work. The final meeting of the spongy iron in the zone of fusion and the fusing together of the earthy matters to form the slag are the last steps in the process.

The quality of the product is dependent mainly upon the composition of the slag and the temperature of the furnace, and by varying either it is possible to change the character of the iron within well defined limits. The temperature of the furnace can be to a certain extent regulated by the temperature to which the blast is heated before entering the furnace, and the composition of the slag can be governed by using an amount of flux that will combine with the earthy matters of the ore and fuel to produce a resultant slag of the desired chemical composition.

In the manufacture of foundry iron the two principal points before the furnaceman are the putting of as much silicon as required into the iron and the elimination of as much sulphur as possible in the slag. The metallurgical condi-

tions that favor high silicon are high temperature and an acid slag, while the conditions that favor low sulphur are high temperature and a basis slag. It can be seen, therefore, that while one condition, that of high temperature, is conducive to the attainment of both high silicon and low sulphur, the other conditions are diametrically opposed. This complication is the principal one that confronts the furnaceman, and requires the closest watching to prevent the furnace producing an undesirable iron. This complication also furnishes certain sets of conditions that produce entirely different results, for by changing the composition of the slag; that is, by making it more acid or basic, by reducing or increasing the limestone, and by changing the temperature at the same time, we can produce an iron containing high silicon and low sulphur; an iron containing high silicon and high sulphur; an iron containing low silicon and low sulphur, and an iron containing low silicon and high sulphur. While the first result is the one aimed at in the production of foundry iron, it is not entirely possible at all times to prevent the furnace from producing either one or all of the others occasionally, according to conditions. If the raw material used had at all times a certain chemical composition and a uniformity of physical structure, the production of a uniform class of iron would be possible, but unfortunately great irregularity in both obtains in all but a few well favored localities, and this irregularity naturally affects the furnace unfavorably, or militates against its uniformity. In addition to the sulphur and silicon, phosphorus and manganese play a very important part in foundry iron, and their control is part of the furnaceman's problem. As phosphorus is practically entirely reduced and combines with the iron under all circumstances, it is controlled entirely outside the furnace by mixing the ores according to their phosphorus content in proportions that will cause the phosphorus in the iron to fall within the specified limits.

Manganese is not subject to absolute control, as under all conditions part of it goes to the iron and part of it enters the slag as oxide of manganese or as a manganate. The conditions that favor the reduction of manganese and its absorption by the iron are high temperature and basic slag, so that while the high temperature which tends to produce high manganese at the same time produces high silicon, the basic or limey slag which tends

to produce low silicon produces high manganese. When the manganese content in the ore is not over 1.00 or 1.50 per cent it is not of much moment, as there is not sufficient manganese to give trouble one way or the other, but when it rises to 2 or 3 per cent., it is necessary in producing a good foundry iron to make the slag as acid as possible without endangering the absorption of sulphur by it, in order to keep the manganese within limits in the iron. When operating in this way the lower the temperature falls the less manganese enters the iron, so that the lower the silicon in the iron the lower the manganese, and as a lowering of temperature with a slag that is not very limey promotes high sulphur, it is also true that the lower the manganese the higher the sulphur in the iron.

The amount of carbon absorbed by iron in the blast furnace is entirely a matter of conjecture from an operating standpoint and while we can tell with reasonable certainty the amount of total carbon the iron will contain, we are not able to govern it. We know that high temperature and high manganese favor the absorption of carbon, but we also know that the excess of carbon absorbed under these conditions is immediately separated upon reaction of temperature and is thrown out by the metal as free graphite or "kish." The condition of the carbon which permanently saturates the iron is dependant mainly upon the amount of silicon and sulphur the iron contains, and by these is to a great intent governed, but not entirely so. General speaking, if we produce an iron that contains high silicon and low sulphur we will have an iron that contains nearly all of its carbon in the form of graphite; but as manganese, the temperature of the iron as it leaves the furnace, its rate of running, and the manner of cooling all have their effect upon the carbon condition we are not certain as to the final result and have no exact means of controlling it. As foundrymen desire an iron that will show to the least degree the effect of sulphur additions from the fuel in the cupola, it is incumbent upon the furnaceman to produce an iron containing as much graphite and as little combined carbon as possible. As we know that by running the iron high in silicon, low in sulphur and containing about 1 per cent of manganese we will most nearly meet the required conditions, we seek to control only the last three and through them obtain a species of control of the carbon.

Some foundrymen insist upon specifying the percentage of graphitic and combined carbon as well as the percentage of silicon, sulphur, phosphorus and manganese in the irons that the purchase, which is a refinement that is not only unnecessary but in some cases even absurd, for the reasons indicated. It is well enough to desire to use an iron containing a certain percentage of combined carbon or graphite, but in case these are specified, fixed percentages of the other elements should not be insisted upon. Furthermore, until we understand with greater clearness the exact nature of the iron carbides in pig iron, and have at hand more ready and direct means of determining them with rapidity and accuracy in the laboratory, their amount should not be specified, particularly as the results desired can be secured with a greater degree of certainty through our more accurate information about the elements, silicon, phosphorus, manganese and sulphur, their influence on carbon conditions, and our ability to more quickly and accurately determine them by chemical means. As we gradually depart from the old method of classifying pig iron by its physical appearance, or by the character of the surface of a fresh fracture, we cannot lose sight of the fact that the chemical composition of the iron has a marked effect upon its physical characteristics, and to-day while many foundrymen who have been educated and trained to the use of pig iron according to its physical appearance have yielded to the modern advance of thought and knowledge to the extent of taking chemical composition into account and specifying the constitutents to meet their needs, they yet tack on the grade to be sure they are right. This multiplicity of specifications furnishes a difficult problem for the furnaceman that finds no ready solution. While as just stated the physical appearance of pig iron is to a certain extent influenced by the chemical composition, the influence of the latter is not evidenced in the same manner at all times, nor does the physical appearance furnish a safe guide to its estimation. It is equally possible to make an No. 1 X iron containing 1.50 per cent. silicon, and a Gray Forge iron containing 3.00 per cent. silicon. While these extreme conditions are usually brought about by variations in the sulphur and manganese, there are other conditions arising from irregularities in the internal condition of the furnace which modify the form of reduction, and influence strongly the physical

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appearance of the iron without greatly modifying its chemical constitution. Such conditions as a slight accumulation on the walls of the furnace which reduces the area and allows a portion of the ore and stone to descend to the tuyeres without having undergone the necessary chemical changes, or causes a freer working on one side than on the other, very markedly influences the physical character of the iron, while the furnace is properly burdened to produce and does produce iron of the proper chemical analysis, so long as the proper temperature are maintained.

The amount of moisture in the air also has a distinct effect upon the physical appearance of the iron, and to some extent effects the chemical analysis, so that in the warm months when there is less oxygen by volume and a greater humidity in the atmosphere, a greater volume of air is required for the furnace and a greater amount of coke is uselessly consumed in dissociating the water vapor at the tuyeres. Under these conditions it is more difficult to produce the highest grades of iron, as the furnace is more sensitive to any changes that may occur at the top.

Of all of material charged into a furnace, the fuel has the greatest bearing not only upon the working of the furnace from a standpoint of tonnage, but also upon the chemical composition of the iron. While the ores are subject to variations that sometimes give rise to unsual conditions, it is not often that these variations cannot be met promptly in a way that will quickly restore the conditions to normal, variations in the fuel cannot be so promptly met and as a consequence have a more marked and lasting effect. It is not often that the ores contain sulphur in excess of an amount readily carried away by the slag, so that practically all the sulphur in the iron is obtained from the sulphur that exist in the coke. The lower the sulphur is in the latter element the more regular are the results therefore, but as a rule the exact chemical analysis of a coke is not so important in blast furnace practice as is the physical structure. The percentage of ash in the coke seems to have a distinct bearing upon the strength, and the writer has from a long series of observations reached the conclusion that coke which contains from nine to twelve per cent. of ash gives the most satisfactory results in the furnace. Since variations in the manner of charging and firing the ovens in the coking process produce marked variations in the physical char-

acter of the resultant coke, the latter presents a lack of uniformity that reacts on the furnaceman to the extent of causing undesired changes in the condition of the furnace. Even from one operation the coke is subject to considerable variation unless that operation is managed with a rigidity of system that does not obtain at the majority of the collieries. As just indicated it is certain that the percentage of ash influences the physical structure of the coke, and it may be possible that this influence is not confined to only this one constituent of the chemical composition, but however this may be it seems that the manner in which the coal is prepared and coked has the greatest influence upon the physical characteristics and to the greatest extent determines the value of the coke as a furnace fuel. Coke having an apparent specific gravity of from .90 to .95 yields the most satisfactorily results in the writer's experience, as coke having this specific gravity has its cell structure sufficiently well developed to allow free access to the gases, and at the same time has a sufficiently great strength to resist the crushing effect of the furnace burden. When coke meets these conditions it is not a matter of great difficulty to secure uniform results from the furnace, as the porosity of the coke and its strength keeps the column of stock in a loose condition allowing free play of the gases and promoting regularity of movement. A change to a harder or denser coke retards the reaction in the top of the furnace on account of the gases having less ready access to the interior of the lumps, and as a consequence too little carbon is freed for deposition in the ore in the upper parts of the furnace, and an excess of coke reaches the tuyere line. A change to a softer and more porous coke on the other hand also retards the reactions in the upper part of the furnace, through the crushing down of the burden and formation of a denser column for the gases to pass through. As the gases seek the lines of least resistance this condition promotes the formation of scaffolds or the accumulation of more or less infusible masses on the walls of the furnace, which militate against the production of high grade iron, and in some cases cause the furnace to be put out for cleaning. From these statements, it may be seen that with good coke and poor ores better results may be obtained in the production of foundry iron, than with good ores and inferior coke.

As the operation of the blast furnace is a continuous process, suspended only in the case of accident or for a few minutes at in-

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tervals for the purpose of tapping the metal, and as each variation in the nature of the raw materials charged causes variations in the reactions in the upper part or the laboratory of the furnace, it follows that variations are almost constantly occuring in the nature of the metal collecting constantly in the crucible of the furnace. While these variations may be only slight under ordinary conditions they are nevertheless variations, and the body of iron that is tapped out at a cast is composed of layers of iron that in some cases have very marked differences in chemical constituents and also differences in physical characteristics. There is no rule by which we can tell what these differences may be except by noting the condition of the furnace at short intervals during the time the iron has been formed, and even in this way it is only a matter of judgment. The writer has noted a variation of 1.27 per cent. in the silicon,and .028 per cent. in the sulphur in a cast of nineteen (19) beds of twenty-five (25) pig each, taking three pigs from each bed and analyzing separately. No variation in the phosphorus was found, and only .30 per cent. variation in the manganese. The average analysis of the whole cast was:

Silicon	2.08	per cent.
Sulphur	.039	
Phosphorus	.76	
Manganese	.72	

While a variation as wide as this may be unusual, it is a matter of fact that no two beds of iron will analyze exactly alike, and it is this variation that very frequently creates controversies between the manufacturer and the consumer, as the manner of sampling causes variation in results more so especially when some of the conditions named have caused numerous slight changes to occur in the working of the furnace in short periods of time. As it is not feasible to analyze each bed of iron on account of the time required the furnaceman secures his analyses from small samples dipped at intervals from the runner and analyzes them separately or combined according as the furnace may be working irregularly or regularly. The information derived in this manner furnishes the basis for the classification of iron, and determines its destination. As it is not possible to entirely overcome all irregularities in foundry iron the furnace should be given sufficient latitude in the matter of specifications to allow for reasonable variations.

In this connection it may be stated as a general proposition that a furnaceman should be allowed the widest limits possible, particularly as regards silicon and sulphur, and that the foundryman should be made acquainted with all the small variations in each car of iron to the fullest extent of the furnaceman's information.

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PERMANENT MOLDS.

BY JAMES A. MURPHY, ERIE, PA.

The casting of large work is at all times an interesting topic to foundrymen, particularly so in loam, when special well got up rigs are described. The art of loam molding has reached a wonderful degree of perfection in some sections of this country, and the best minds are directed to the saving of as much as possible of each mold in order to reduce to a minimum the cost of all castings after the first. In other words the permanent mold is the object sought.

It is a common argument against loam molding that its cost is too high, and I have no doubt but that this is true when work is made in loam that should be made in sand. As a rule those whom I have found prejudiced against loam on account of its cost knew so little about it that I could not consider them competent judges.

Large kettles, such as shown in Fig. 1, pans, domes, pipes, etc., are cheapest made in permanent loam molds. In some instances iron casings would still be cheaper. There are shops that make such castings in sand, but I consider them not up on the modern way of doing things. This kettle weighs about 14 tons and is made very quickly when the proper rigs and equipment are available.

The mold is absolutely permanent, the only preparation necessary being the daubing on of the loam, blacking it, and as the bricks are hot when in use a small fire placed inside of it will dry it thoroughly in a few hours. The core is swept up and is preferably dryed in an oven. The whole core can be made of iron staves, but I consider the rig shown with the greater part of the core laid up with brick the quickest, safest and most satisfactory method.

To start the job we must dig a pit in the floor in some convenient place and the binders A and bottom plate B (Fig. 1) made and set as well as the spindle step C in which to set the

mold sweep (Fig. 6). Bricks are then laid to the outline allowing from 1-2″ to 3-4″ for loam. If the bricks are not of good quality it is best to have the face of the mold laid with fire bricks, using the common ones for backing. When built up to within about a foot of the top it is best to get on the octagonal lines and on their centres build in 8 iron frames (Fig. 7 and D Fig. 1) with liberal draft. In these can be set cores for handles, brackets or other external projections and when the casting is taken out the wall will not be in the least disturbed.

On top of the wall lay a strong cast iron ring (Fig. 8 and E Fig. 1) recessed on the octagonal lines sufficient to clear the iron boxes just mentioned, leaving space enough on top for a face of loam on the joint. This when bolted down firmly (F. Fig. 1)

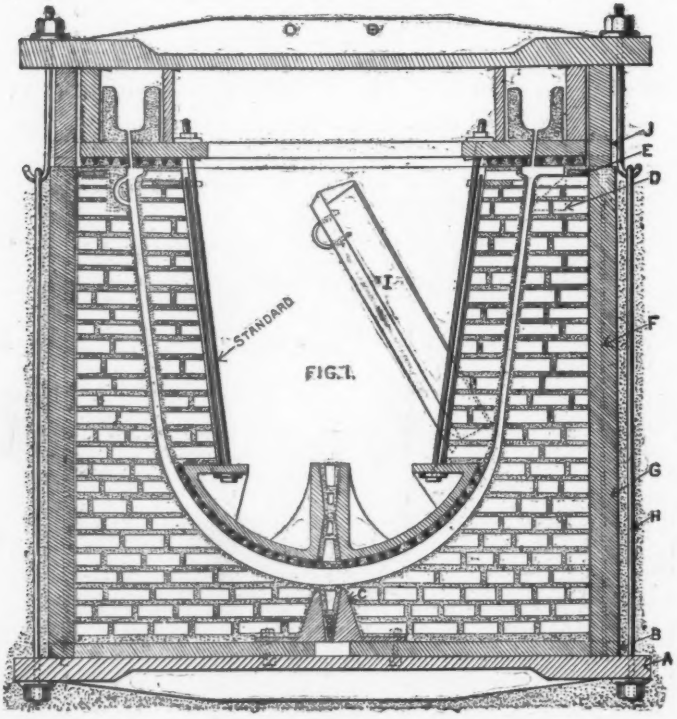

FIG. 1.

to the bottom plate will prevent the loosening of a single brick. The brick part of the mold being finished, the columns G and bolting rods H are placed and the nature of the soil would have to determine whether a curbing was necessary or not before ram-

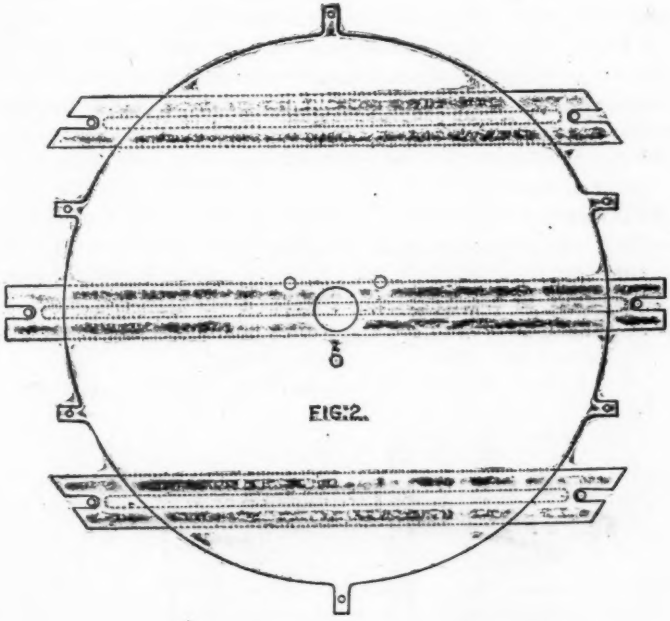

FIG. 2.

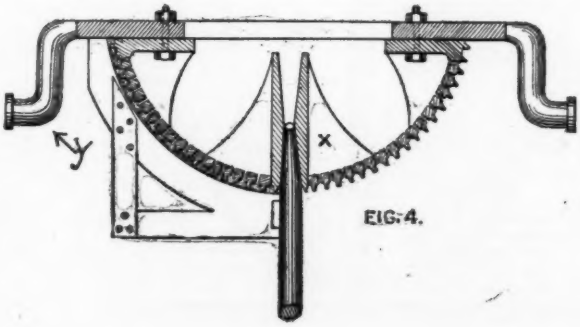

FIG. 4.

ming up the mold permanently. Plenty of fine cinders should be used between the brick work bringing all the gases to the outside of the wall quickly where provision should be made to convey them away.

For the core it is best to make one or more crown plates (X Fig. 4) and I consider the one shown an improvement on any similar "get-up" that I have seen. It is cheapest and best when swept up in loam with a straight hole cored through its hub, which can afterwards be machined to suit the taper of the spindle. It can be laid on the roll-over plate (Y Fig. 4) spindle set in and plumbed true, loam rubbed on, swept and finished, when hardened with a fire basket it can be turned over set in the form as shown in Fig. 3, spindle set in the other side and the building of the core proceeded with. To provide for shrinkage and prevent extra labor and save some bricks from being badly broken, it is handy to build in a splitting bar (I Fig. 1), which can be easily pulled away with the crane after pouring, allowing the wall to give with the contraction of the casting.

When the core is built, an iron lifting ring is secured on top

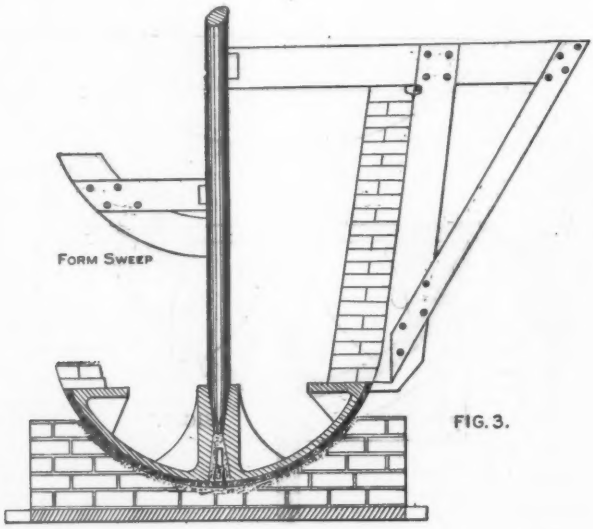

FIG. 3.

of it, and by means of this it is set on a form similar to Fig. 3, on the oven carriage. When dry this is taken away and the flat top plate J lowered on it, and the core bolted securely to it. The whole thing is lifted by the top plate and closed by the center lines. I prefer running this on top similar to the way shown, each gate being stopped until the runner is full. Risers left open to relieve the pressure of air, prevent the back kick and thus obviate the wrinkles that would mar the appearance of the casting, particularly so if the metal was not very hot. The riser basin should be ample and be so arranged that it can be flowed off to take away the metal from the runner so as not to have a heavy piece of scrap to break.

The mold is thoroughly secure and not much more costly than if only one casting was intended to be made. As shown it

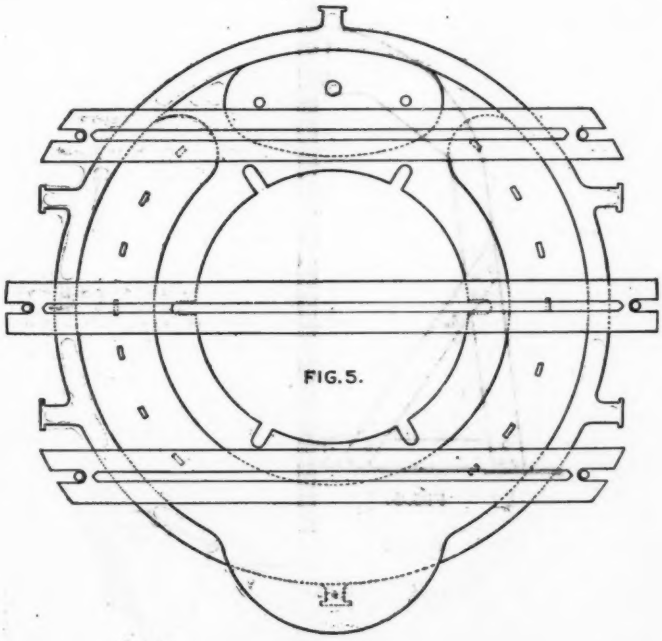

FIG. 5.

will last for several years continuous service. Any shop equipped. for large work should, with a rig of this kind, turn out one of these kettles every few days. As thus arranged it is seldom that a first-class workman need be put on the job, everything being made to prevent possible mistake by other than the grossest carelessness. It is however, advisable for the foreman to keep an eye to starboard in any case, as I recollect a case where after everything was seen to and considered safe, the unlooked for happened. It seems that a bag of hay used by the molder as a seat for the ladder was forgotten by him in the mold at the last moment, of course the casting was lost by having a large hole in its bottom, all of which makes one wish that the molder had forgotten to come out also.

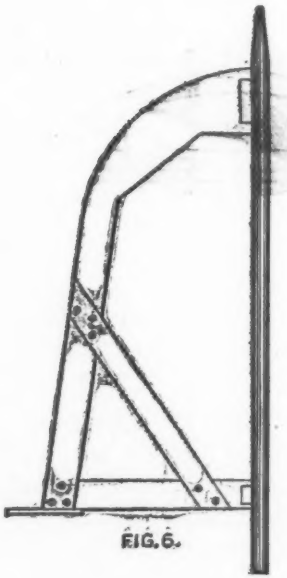

FIG. 6.

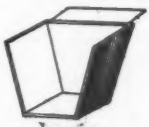

FIG. 7.

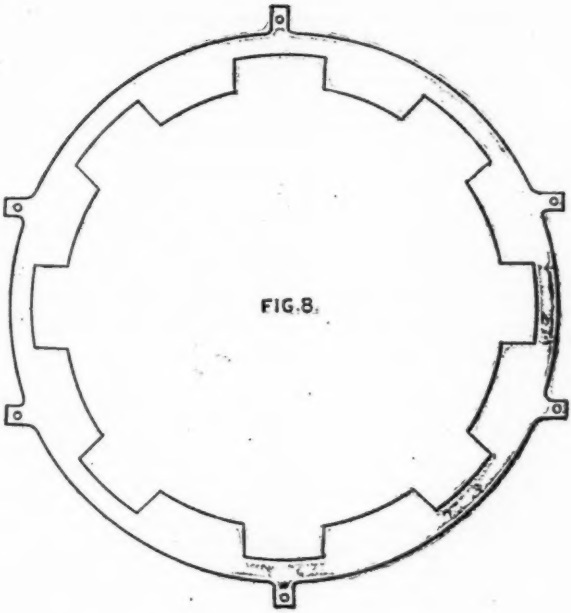

FIG.8.

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RETORT OVEN COKE FOR FOUNDRY USE.

BY W. J. KEEP, DETROIT, MICH.

My excuse for saying a few words on this subject is that for a year and a half I have used retort oven coke exclusively, melting about 80 tons of iron per day. I have used coke made at three different plants, from Hamilton, O., Sharon, Pa., and Detroit. This coke was made from a great variety of coals from West Virginia and Pennsylvania. The coke used during 1902 was made in Detroit and was uniformly good. At times during January and February of this year we received some coke that was not satisfactory because the makers could not procure proper coal owing to transportation difficulties. When this condition changed the coke again became satisfactory and has continued to be so.

During these same early months of 1903 founders all over the country had trouble with coke in bee hive ovens. Founders in many parts of the country were obliged to take any kind of coke that they could get in order to keep running.

During the past season most of the best deposits of coking coal in the Connellsville region have been purchased by the United States Steel corporation and very little genuine Connellsville coke is available for general foundry use.

It may be interesting to described in a few words the old fashioned bee hive oven and the newer retort-oven.

The beehive oven takes its name from its interior having the shape of the old dome shaped beehive. The size is generally from 8 to 12 feet in diameter and from 6 to 8 feet high. The coal is charged through a hole in the top and is spread evenly over the floor to a depth of 18 to 28 inches. There is as much space left over the coal for the burning of the gases as is occupied by the charge of coal. The brick work of the oven being still hot from the heat of the previous charge soon causes the fresh charge to ignite and distil off the gases, which are burned in the dome above the coal. The heat being reflected downward causes the

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distillation to gradually proceed toward the bottom of the coal. When all the gas is driven off, which takes from 48 to 72 hours, the coke is quenched while yet in the oven.

The bright glistening surface of Connellsville coke is principally due to this quenching inside the oven and the columnar structure is due to the gas rising vertically as the coking proceeds downwards. Black-heads are the lower portions of the charge that rest on the floor of the oven and which are not thoroughly coked.

As in this method of coking the only product obtained is the coke and owing to the combustion taking place in the oven itself the yield of coke is generally somewhat less than the theoretical, owing to the combustion of a small quantity of the fixed carbon of the coal.

The retort oven is a closed chamber from 15 to 24 inches in width and from 5 to 8 feet in height, and from 25 to 45 feet in length. From 25 to 50 of these ovens are placed in a battery. The coal is charged through three or more openings in the top and leveled off to within a foot of the roof, after which the oven is carefully closed and sealed in order to exclude the air.

The oven is heated by the combustion of a portion of the gas driven off in the process of coking. This is not burned in the oven itself, but it burned in flues constructed in the walls of the individual ovens.

The heat is conducted through the walls of these combustion flues to the charge of coal and distillation thereof is started immediately. The gas which is driven off is conducted through a series of apparatus in which the tar and ammonia are recovered, after which a portion of the gas is returned to be burned in the oven flues and the balance is disposed of as local conditions determine.

Distillation proceeds from the side walls toward the middle of the oven and the gas is probably driven toward the centre of the oven where it rises forming a cleavage plane the whole length of the oven. When the process is completed which takes place in from 20 to 36 hours depending upon the width of the oven, and the temperature maintained, the whole charge is pushed out by a steam or electric ram and is immediately quenched. The oven is at once closed and without any loss of.

heat from the oven itself is again charged with coal.

On account of the cleavage plane through the centre of the charge no piece of coke can be longer than half the width of the oven. Owing to the complete exclusion of air there is no combustion in the oven and as the temperature of the oven when the coal is charged, is very high there is a considerable decomposition of volatile matter with consequent deposition of carbon upon the coking charge; as a result the yield of coke is a little higher than the theoretical yield as calculated from the analysis of the coal. Quenching the coke outside the ovens mars the appearance of the coke, somewhat destroying its bright silvery lustre, but probably results in carrying off an appreciable quantity of sulphur.

It is evident from a comparison of these two methods that coke made from the same coal will have a slightly higher percentage of fixed carbon and a slightly lower percentage of ash if made in a retort oven.

The beehive oven is almost universally located at the mines from which it draws its supply of coal. Retort ovens are located in places that provide a market for the coke and gas.

To allow a continuous operation of a retort-oven plant the product must be sold as fast as made and to do this a uniform quality of foundry coke must be maintained.

The quality of retort-oven coke depends upon the skill of the operator, upon the method of preparing the coal and more than all upon the quality of the coal used.

Our experienced with retort-oven coke began during the fall of 1901. We were at first induced to try one car and when it arrived it was so black and in such small pieces and looked so badly that we refused to try it in a cupola, but the makers proposed to pay for all poor castings and under these conditions we used it in the same proportion as the Stonega beehive coke that we had been using previously. The iron was very hot and satisfactory.

We ordered five cars more and ordered retort-oven coke from other ovens until we decided that the coke worked well in spite of its very bad appearance. From that time to this we have never had a pound of other coke. All through 1902 the coke was so uniform and satisfactory that we melted 9 pounds of iron with 1 pound of coke.

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There is a great advantage in having a local retort-oven coke plant, because it enables the founder to keep in close touch with the source of his supply.

Owing to the necessity of having a laboratory at a retort-oven plant to keep track of by-products the coke manufacturer keeps himself informed as to the chemical composition of his coal and coke and can make a very uniform product.

Such local coke plant will have a very large variety of customers and therefore can supply the founder with a very uniform quality of coke because any inferior coke can be sold to domestic users or to manufacturers where it will do no harm.

Experience has proven that with a retort-oven satisfactory foundry coke can be made from coal that when coked in a bee-hive oven would be unfit for foundry use.

This helps the founder in that it greatly widens the field from which he can draw his future supply of fuel.

Retort ovens are at present being erected in various cities and I understand that an eighty oven plant will be in operation in Milwaukee in a few months. This will be a great relief to the founders of this city.

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A SIMPLE DEVICE FOR ASCERTAINING THE AVERAGE SILICON IN AN IRON MIXTURE.

BY ARTHUR W. WALKER, BOSTON, MASS.

The device consists of a balanced scale, having a single beam on one side of the fulcrum, as shown in the sketch, and any number of beams on the other side; in the illustration there are four of these beams, which are shown on the left of the supports. For the scale beams on the left side, small weights are used, each weight representing a certain kind of iron, and the weight being varied to represent the percentage of silicon contained in the iron which it represents.

In the scale which we are using each ounce in the left hand weights represents one per cent. of silicon, and the weights can be arranged by adding weights of various amounts, so that they will correspond to the percentage of silicon in the various irons used, each weight representing one kind of iron.

Having arranged the weights in conformity to the percentage of silicon in the various irons, the weights are placed in position on the left hand scale beams in accordance with the quantity of each iron which it is intended to use. The instrument we are using is designed for a net ton, or 2000 pounds. As shown in the sketch the weight on the front scale beam is set at 600 pounds, indicating that for that particular iron it is proposed to use 600 pounds in a net ton. On the second beam the weight is set at 400 pounds, indicating that 400 pounds of that iron will be used. On the next beam the weight is set at 800 pounds, and on the rear beam the weight is set at 200 pounds. It will be noted that these weights make 2000 pounds in all. Having placed the weights in conformity with the proposed mixture, the right-hand weight is moved along the scale, until it balances the left-hand weights, and when the right-hand weight exactly balances the others, its position on the scale indicates the average silicon. From this may be deducted the expect-

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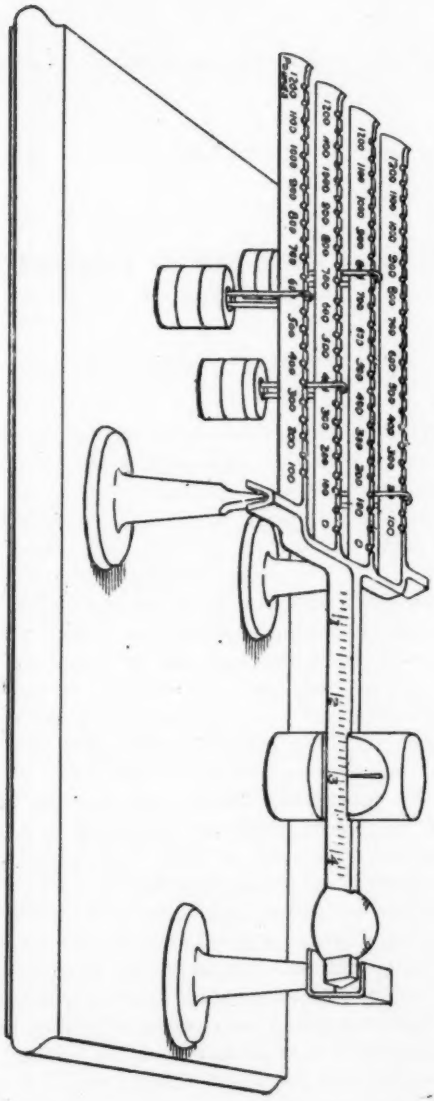
ed loss in silicon (say one-quarter of one per cent) or the right-hand weight can be made to allow for this without any figuring whatever.

It is obvious, of course, that the instrument may be used in the opposite way from the above, setting the right-hand weight at the silicon desired, and then adjusting the left-hand weights until they balance, remembering that the total must always be 2000 pounds for the left-hand weights.

If it is desired to ascertain the mixture in a charge larger or smaller than 2000 pounds, it is only necessary to change the large weight on the right-hand beam. In the device we use, this weighs ten ounces, and for a charge of say, 1200 pounds, it would be changed for one weighing six ounces.

There is, of course, no objection to placing two or more of the weights on the left-hand scale; indeed, a single scale on the left would serve for all the different weights used; it is thought that the use of a number of scale beams makes the device easier to use and understand.

This instrument can also be used to determine the average of any other element in the iron.



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LOSS OF SULPHUR IN BORINGS OF PIG OR CAST IRON.

BY W. E. DICKSON, SHARPESVILLE, PA.

A few years ago I found myself obtaining high results in the determination of sulphur in pig iron. My method was the usual one of evolving the sulphur as hydrogen sulphide, absorbing the gas in an alkaline solution of cadmium salt, acidifying and finally titrating with a standard solution of iodine, the factor of which was obtained from results given by standard borings.

After examining all details of my work without finding any source of error, I made an examination of my standard borings and to my surprise, found that the standard, which was supposed to evolve .040 per cent. sulphur, was only giving off .030 per cent. Thus, after putting a portion of standard borings through the regular process of analysis, I would divide .040 by the number of cubic centimeters of iodine required for the final reaction to obtain my factor. As the standard proved to be giving off only .030 per cent sulphur it is obvious that the factor would be one-third too high and all results obtained by its use correspondingly so.

Thinking the standard might have been improperly prepared, I made up another one, using every precaution to secure a good, clean, thoroughly mixed lot of borings. After establishing its sulphur value, based on the results of a number of chemists, it was carefully bottled and sealed and stored away with the exception of a small portion needed for frequent use in standardizing.

For a time this standard gave the best of results, but after a while it began to give a higher factor than that obtained by use of a steel sulphur standard which had agreed closely with it at first. Portions from the sealed bottles showed the same change and a

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careful re-analysis of the standard showed that it was evolving less sulphur than the value assigned to it while the steel standard gave the same as before.

Turning to a number of other standards in my possession I examined them and found a loss in all those made from pig or cast iron. Those made from steel had undergone no appreciable change. The regular sample of the pig iron, reserved in the laboratory for checking in case results were questioned, showed a large loss of sulphur even though the time intervening between the first and later tests was short.

Some results obtained from operation on the standards were as follows :

Standard	Original Value	Present Value	Character of borings
No. 1	.053	.042	Borings passed over 80 mesh sieve to remove dust.
No. 2	.051	.047	Coarse borings broken up in mortar to pass through 20 mesh and over 80 mesh.
No. 3	.040	.028	Borings just as they came from drill.
No. 4	.056	.031	Borings fine and dusty. Very old standard.
No. 5	.057	.041	Borings just as they came from drill.
B	.038	.036	American Foundry Association standard.
C	.059	.048	American Foundry Association standard.

Steel standards showed no loss.

In borings of cast iron every particle is cracked throughout, becoming a porous mass—offering a very large surface for action of outside influences such as acids, when attempting to dissolve the material, or air and moisture in causing oxidation.

On the other hand the soft steel rolls up in a compact lump presenting little surface for the action of such influences.

With this in mind it seems possible that the loss may be due to a slow oxidation of the sulphur taking place on the large surface exposed by the porous particle of iron while the surface presented for action on the steel is so small that it would be a long time before sufficient loss occurred to become noticeable.

Whatever the cause, I believe it is certain that borings of pig or cast iron, even though kept with all of the care given to stand-

ards, lose very appreciable amounts of sulphur on standing and the widespread use of the above or similar methods for the determination of sulphur should cause the fact to be of interest to chemists engaged in the analysis of iron.

Possibly others have noted the phenomena before I did and have better ideas of the cause or remedies for it but, to the best of my knowledge, it has never been brought out for discussion, and in submitting my results to the American Foundrymen's Association, I wait with interest to hear what others have to say about it.

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VOL. XII. JUNE, 1903. PART I.

NOTE ON ESTIMATING METHODS.

BY WM. HANSON, PHILADELPHIA, PA.

As the question of uniformity in office methods of estimating on castings is beginning to attract some attention in foundry circles, I append the blanks in use by me to facilitate and at the same time properly record the data used.

The cost of the iron melted is obtained from the daily reports substituting the irons intended to be used for the work in question, which may be varied to suit the occasion. (Fig. 1)

Fig. 2 illustrates the method of getting the detailed cost of castings. The headings explain themselves, a special column being allowed for additional expenses from whatever cause these may be expected to come. On the same sheet is given the summarized estimate of castings. The whole gives a clear tabular statement upon which to build when sending in estimates on work.

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Metals				Fuel				Flux	Labor	Pow'r
				COKE		WOOD				
Brand	Weight	Price	Value	Weight	Value	Quantity	Value			
.....	.....	.....	.....							
.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
.....	.....	.....	.....							
.....	.....	.....	.....							
.....	.....	.....	.....							
.....	.....	.....	.....							
.....	.....	.....	.....							
Total		$								
Pig bed		lbs.	$							

$.....

lb. ..... per lb. Average Cost.

Date .....

Supt. .....

Detailed Estimate of Castings.

DRAWING	Moulding	Helping	Core Making	Iron Melted c. per 100	Cleaning	Shipping	Crane Rate	Supplies	Weight in Pounds	Cost of one casting	Additional for expenses	Cost per pound	Date ..... REMARKS

Summarized Estimate of Castings.

DRAWING	No. of castings required	Total weight	Cost per pound	Price per pound	Total cost	Total value	

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BUYING PIG IRON ON SPECIFICATION.

BY HERBERT E. FIELD, ANSONIA, CONN.

History has in truth repeated itself and we are again face to face with a declining pig iron market. Some are prepared to take advantage of the drop in price of material to fulfill contracts based upon the higher prices. Others, however, are now receiving iron bought at a high price for previous delivery and are fearful lest the decline in raw material be accompanied by a like drop in the price of castings.

We have little sympathy with the man who, from lack of foresight, finds himself with a large amount of high priced iron and a declining market. We have sympathised with the one who had foreseen the rise and had bought liberally to cover future needs and then, through failure of the furnace in filling the contract, was forced to buy spot iron at top of market price to use in place of the iron contracted for at a much lower figure.

The use of specifications in buying pig iron is becoming quite general. An old saying that "A little knowledge is a dangerous thing" applies in the iron business as well as elsewhere. But let me change it a little: "A little specifying is a dangerous thing," and it will stand very well for the text of my paper.

Man has from the beginning found excuses for wrong doing, or failure to do what was right. Some pig iron furnaces have, in previous changes in the market, found excuses for failing to fulfill contracts. We have, however, given them better excuses by placing analytical specifications in their hands. Some of them have been quick to make use of the excuse. Previous to the last phenomenal rise in pig iron, many buyers, taking lesson from previous experience with poor iron shipped from furnaces forced beyond their capacity, very shrewdly bought their iron upon specified analysis. They were sure then to get good iron, or they could reject it. So far so good. Let me illustrate how this turned

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out in many instances. The founder bought at a low price, say $16.00 for future delivery. The time comes for the delivery. If he gets it he may find it does not come within the specifications but is inferior iron. He complains and is very politely informed that the makers are most sorry, and that they will see that the iron is taken out, as they have a customer for just that grade. They agree to replace it with iron within specifications but the furnace is running "off" a little just now, coke is bad and scarce, and their furnace is running on a lower grade. As soon as it rights itself they will ship the desired kind. They regret the circumstance and are sorry to inconvenience their customer, etc., etc. You have all read it and heard it; have dreamed it as you saw your iron pile grow low and the price grow high. Your faith in human nature increases as you weep in sympathy with the furnaceman in his sorrow at not being able to supply the grade that you must have. You can see how pained he must be that he really cannot make the iron which he must sell you at $16.00, but that he can only make a lower grade and sell it on the increased market at $20.00 to $22.00. You can see how hard it must be for him when he is forced to accept $4.00 to $6.00 a ton more for a No. 3 when he really could be making a No. 1 or No. 2 at a greater cost and selling it to you for less money. What are your specifications worth now? You must buy a high grade iron to mix with it or stand the complaint of your customers on account of inferior castings. If you order the iron to be taken out, you must buy iron to replace it at a greatly increased cost and your foresight in buying on a low market nets you nothing. Some of you may say that such a one was fortunate to get any iron at all. It would almost seem that some furnaces purposely run on grades which could not fill the wants of their customers and then sold the product at a better price than they would have received on their contract for the higher grades. It is difficult to resist the temptation during such times to run furnaces beyond their capacity for making high grade irons. It is a strange coincidence that when the price drops below that for which the iron was contracted, the furnace generally gets "on" again and makes a few hundred tons just to fill the order. You are glad to see it coming, especially if you have filled your yard with iron at a high price. You realize that if it had come in when it should you

would have been thousands to the good. You feel towards that iron as the other son did to the prodigal.

You say these have been exceptional times. They surely have. Two such times in 6 years should furnish about all the experience that is necessary. I bring this subject up for consideration at this time in hopes that foundrymen will do something to prevent a third.

That furnaces can fulfill specifications is shown whenever the supply exceeds the demand and there is competition for orders. There may be a certain satisfaction at such times, in refusing to take iron which does not come up to specifications, but this does not tend to a steadiness which is best suited for prolonged prosperity.

We hear repeated statements that the modern furnaceman is not only willing but anxious to sell by analysis. To be sure this anxiety is often proportionate to the amount of iron he has to sell.

Let us, however, assume for discussion's sake that the furnace can and will sell by analysis. Specifications and standards are two of the key notes in modern industrial advancement. The American Foundrymen's Association has for some years realized the importance of standards in up-to-date foundry practice.. Its work on standard test bars was monumental in its extent and it has laid a foundation for the testing of cast iron. The work of its standardizing committee in preparing standard samples for analysis has given the Association a world wide reputation in that line. The Metallurgical Section is at present working on standard methods for analyzing iron. Standard methods for sampling pig iron have been submitted to this Association for approval. Standards tend toward stability, and anything which lends stability to business, whether it be stocks or foundry business, should be encouraged. Will standard specifications for the purchasing of pig iron overcome the difficulties which so many have experienced in the last year or two?

The American Society for Testing Materials has appointed a committee to take up the matter of standard specifications for pig iron. The writer desires, if possible, to introduce a discussion among the users of pig iron in order to bring out the sentiments of those who will be the most benefited by such specifica-

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tions. Specifications may look well in print; they may show the best thought of the experts engaged in drawing them up, but they will be useless unless they are given the support of the buyers of pig iron. Will it be possible to draw up specifications which will cover emergencies and prevent the difficulties to which I have previously alluded. If this is not possible then they will not be worth the paper on which they are printed, to say nothing of the labor of getting them up. As matters stand now in the pig iron business, when the supply is equal or in excess of the demand, if a foundryman knows what he wants, he can get it without regard to standard specifications. If, however, the demand exceeds the supply, and the market is rising, the purchaser is pretty apt to take what the furnaceman sends him and be very glad to get iron, regardless of whether it fills the specifications or not. The utility of specifications will depend upon two facts, first, the inherent value of the specification itself, in being so framed as to prevent the above difficulty, and second, the support given the specification by the purchasers of pig iron.

What ranges in analysis shall constitute each grade? How great a variation shall be allowed from the specifications? What shall determine the true grading of the iron? How shall it be sampled and analyzed? These are a few of the important questions to be covered by specifications, but they are not enough. Specifications must be framed so as to guarantee to the founder the product that he has bought. If iron is bought at a contract price on a guaranteed analysis, the order should include a clause which gives the buyer an option to accept or refuse the iron if it does not come within the guaranteed specifications. It should go further, it should give the buyer the privilege of accepting the iron at a reduced price; the reduction to be covered by the specifications and not left to argument after the trouble has appeared. For example, a purchaser buys pig iron of guaranteed silicon 2.50—3.00, Sulphur—.03, Phosphorus—.7, etc. When he receives this iron he finds it runs 2 per cent. in silicon, .06 in sulphur and 1 per cent. in Phosphorus. The purchaser should have the option of a fixed reduction in price guaranteed by the specifications. The price should allow him so much per ton reduction for every .25 of 1 per cent. in silicon that the iron falls below the specifications. It should allow him a fixed amount for every .01

of 1 per cent. of Sulphur and every .1 of 1 per cent. in Phosphorus by which this analysis exceeds the guarantee. The benefits to be derived from such a specification are obvious. In the first place it would make the furnaceman more careful in selecting the iron to fill such orders. He could not feel assured as many have been able to in the last shortage that the iron would be accepted and paid for whatever it was. In the second place it would give to the purchaser a reduction in price which would repay him for the excess in per cent. of pig iron that he was obliged to carry in his mixture, or it would allow him to purchase high silicon, high manganese or low phosphorus iron to mix with the inferior iron and bring it up to the required standard without increasing the cost of his mixture. Such specifications would overcome the chief difficulties which founders have experienced in buying on specified analysis. These difficulties as stated earlier in the paper consist of the indifference which furnaces have shown in fulfilling specifications in rush times, and the use which they have made of the specifications to excuse them for not shipping iron bought at a low price, when the price has advanced. If the furnacemen said that they could not make iron within the specifications on account of the hundred and one reasons well known to you all, you would have the privilege of telling them to send you the best they could but at a price fixed by your specifications and depending upon the variation from the guarantee. This reduction in price should be proportioned in such a manner as to cover the cost of iron used in bringing the mixture up to specified analysis.

I do not claim that such a course would completely overcome the difficulty. There are dishonest people in the pig iron business, as well as in the foundry business. If you have bought low and the furnaceman does not intend to ship you iron on a high market, there has yet to be found a means of forcing him to do so. There is, however, a course open to you when he does desire to fill your order on a falling market, viz., to refuse it on the ground that it was not delivered at specified time. This leads to a third clause which should be included in all specifications. If the pig iron is not delivered in the specified time, the buyer should have the privilege of cancelling the order. This latter course is frequently taken advantage of regardless of agreement, but our pig iron friends have hard names and feelings for the

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ones who take that privilege. Included in the specifications, it would form a part of the contract and would be expected, and thus would form an incentive to the furnaceman to fill his contract on time.

Just why the furnaces have been given such leaway is a matter which puzzles many. A furnaceman may sell iron way beyond the capacity of his furnace and then expect sympathy when some firm whose orders he has failed to fill in guaranteed time, and who has had to purchase iron at a much higher price, declines to take the iron on a falling market. I think that we all appreciate the difficulties under which a furnaceman works; in fact, I think our pig iron friends have taught us to over-appreciate it, and that the furnaces take advantage of this fact many times. Modern blast furnace practice makes possible the production of a more uniform grade of iron than the old regime could accomplish. We have a right to expect and require more of the furnaces, but do we? A furnace running well within its capacity with the proper amount of fuel and the proper amount and kind of ore and flux, will produce a certain grade of iron. A furnace run beyond its capacity with the object of increasing its output may produce a fairly good grade of iron, but the furnaceman tells me that a furnace pushed in this way is much more apt to run "off". The founder is thus often expected to accept the explanation that the furnace is running "off" as some mysterious condition wholly beyond the control of the furnaceman, when in reality it is too often due to a desire to get more from the furnace than it will produce, or to the fact that the rise in price has made it possible to sell the increased output of the off product at a higher price than they would have obtained for their higher grades.

We are often told that iron bought under such strict specifications would be more expensive, and that the furnaceman would be forced to get a higher price for his iron. I am not so sure that this would be the case. When the market is normal and the supply and demand are somewhat equal, competition will accomplish all that specifications will. It is during the shortages such as we have recently experienced that our specifications would prove a restraint upon the furnaceman and if appearances are correct, they could stand a little slicing of their profits and still remain solvent.

Let us admit however, that there would be a slight increase in the cost of iron sold under specifications. Would it not be more than counterbalanced by the security that a buyer would feel in knowing that he would obtain the iron for which he had contracted or an equivalent decrease in price on another iron? The unhealthy, unnatural rise in price of iron together with the inability of the furnace to fulfill contracts has lead to a heavy buying of foreign iron, and a consequent reduction in the price of the home product. Anything which tends to a steady, uniform price should be welcomed by both producer and consumer. It would be a great advantage to the founder to be able to make prices on castings, knowing that the pig iron would be delivered according to specifications. This would more than compensate for the slight increase in price which the furnace might be obliged to obtain for iron sold under such specifications.

These suggestions in regard to specifications are advanced in hopes of bringing about a discussion in which other and perhaps more important points might be brought out.

So much for the specification itself—let us consider for a moment its use. A concern makes out a set of specifications for their own use. The furnace sees in them requirements which they are not obliged to meet in order to get business, and the specifications are refused or a price quoted which makes the placing of the order impossible. This would be the result of any radical change in pig iron specifications advanced by one firm alone. In order to guarantee their success the specifications must come as a general demand from a large number of foundrymen. This Association, standing as it does as the representative of the foundries of this country, could make such a project a success.

In order to successfully introduce such specifications, the time must be opportune. Such a time is evidently at hand. I do not believe that the foundrymen of this country care to go through a third experience to teach them that something should be done to prevent a recurrence. Standard specifications with restrictive clauses, backed by the universal demand of foundrymen for their fulfillment, would be a long step in solving what has turned out to be a very difficult problem.

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MOLDING MACHINES.

BY EDWARD B. GILMOUR, PEORIA, ILL.

The introduction of the molding machine into the foundry has been the cause of many a heated argument. Articles have been written and discussed from a trade's protection standpoint, and vica versa; also from the standpoint of the incessant demand upon the market for increased production of certain articles, thus necessarily compelling the foundrymen to wake up and follow the demand.

The molder refused to work upon these machines or at least refused to put up the amount of work necessary to pay for the investment simply on account of the fact that he became a mere automaton. The mechanic who worked these machines was a mere pounder of sand, and consequently, in order to bring these machines into successful use, the manufacturer was compelled to employ unskilled labor. The molding machine has been in the foundry for a number of years, but only recently has it received the attention which it deserves, and that simply because completion has made the progressive foundrymen devise the most effective and economical methods to produce the best results, and at the same time get as near as possible perfect castings.

One of the most advantageous positions to be attained in a successful foundry is the ability to carry on the work in the least possible amount of space, more especially in prosperous times when floor space is at a premium, all foundries being then too small for their requirements. Here is the where the molding machine comes in.

In the first place plate molding was resorted to on account of the accuracy of the castings made thereby, the patterns did not have the rapping, shaking, and twisting which is usually given in order to get them out of the sand, and as a natural consequence the castings were more perfect and in many cases could be used in the rough state without any machine work having to be done on them. Afterwards the more improved method of the stripping plate was introduced which is giving very satisfactory

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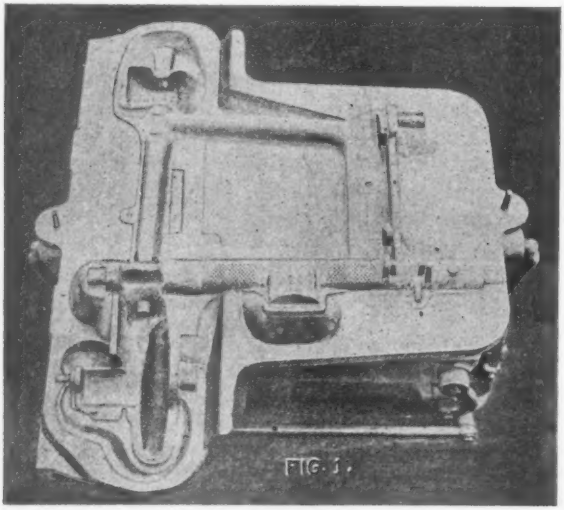
results. The great aim of the manufacturer of molding machine is to do away with the ramming of the sand. In a great many cases he has been very successful, but as a rule only upon what may be termed flat backs.



The great trouble with the "squeezer" is that it makes the outer surface of the mold so hard that it is difficult for the gases to find an easy exit through the sand. In order to obviate this trouble, a loose frame the size of the flask about one inch and half thick is placed over the top of the flask so that when the mold is sqeezed this frame is removed and the hard surface of the sand scraped of in line with the flask. Another difficulty in employing squeezing machines is that there is a large amount of sand right about the operator's feet. In order to get rid of the sand the conveyer was designed so that the sand as it is required would simply drop down upon the flask. This again has not proved as successful as might have been expected, because in many instances just as much work is accomplished by the use of the shovel, thereby saving the very expensive conveyers and shortening the great distance necessary to carry the flasks from the machine to the floor. The same principle holds good in this as it

does in the old style of "snap benches" which are fastened to the wall as against the new style which have casters attached, this

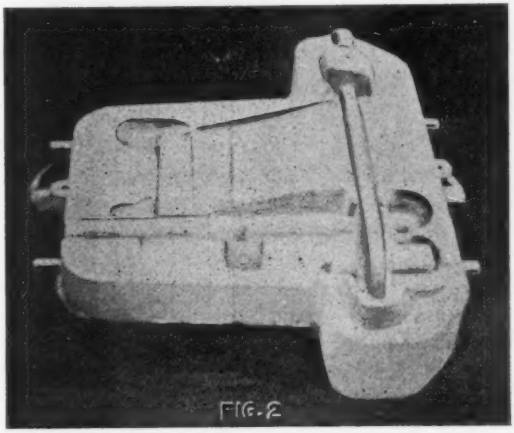


FIG. 2

also being the case in some of the hand squeezers, so that they can be moved about as the sand is used up.

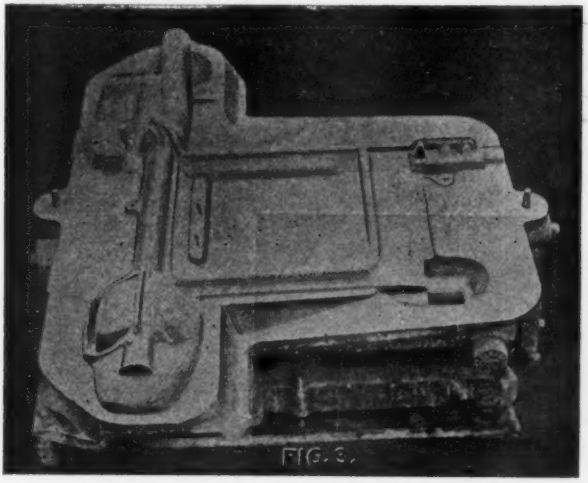


FIG. 3.

The method of making stripping plate machines is very sim-

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ple, and in many cases almost as cheap as would be the regular gate of patterns with match board. This will be seen from the

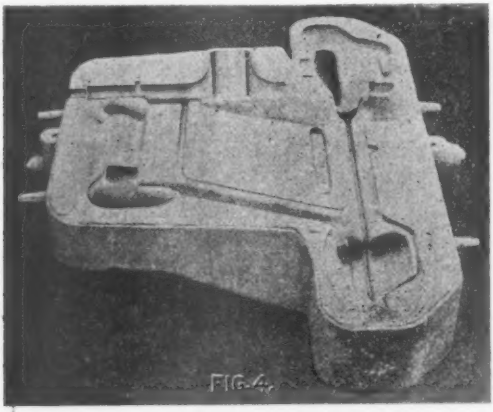


FIG. 4.

following cuts. A flat plate is cast having a hole cut the shape of the pattern with about $\frac{3}{4}$ of an inch clearance around the pattern.

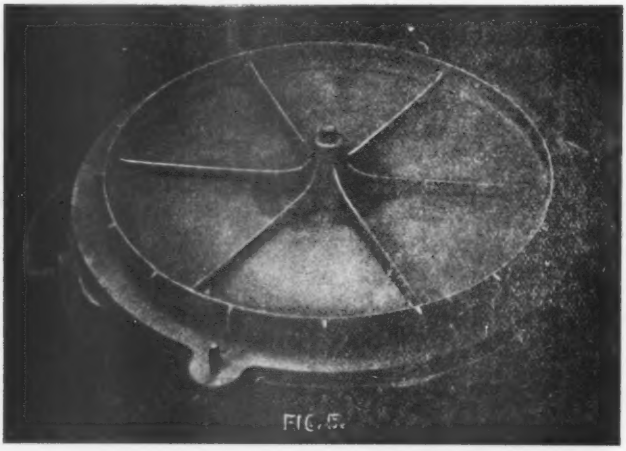
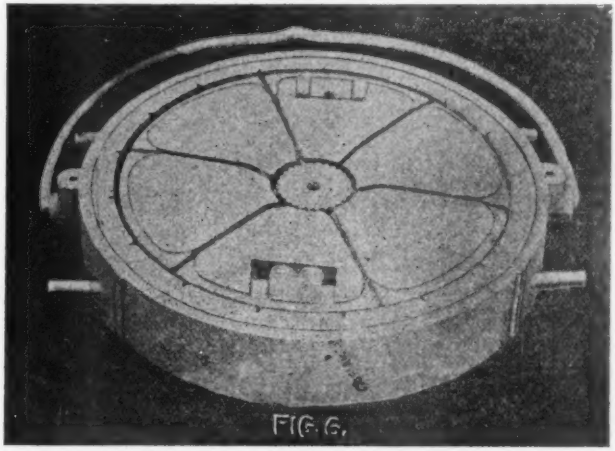


FIG. 5.

Slots or nails are put in the edges of the plates to hold the soft metal, a very good composition for which is 8 parts of tin, 4 of

lead, and one of bismuth. This metal is very fusible and is poured around the pattern into the clearance space. The pattern is then



taken away and the lower edge is bevelled to reduce the friction in dropping the pattern when the mold is made.

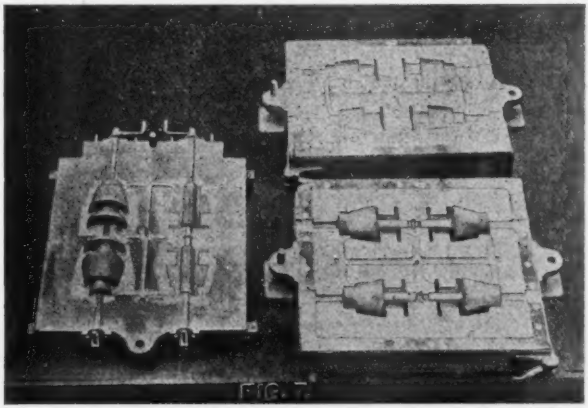


Fig. 1 is the drag part of a complicated stripping plate drop pattern machine for molding more frames, the first cost of this

machine is great, but when you consider the difference in cost of the castings, it would be cheap at double the price, as the reduction in cost in this instance is over 75 per cent.

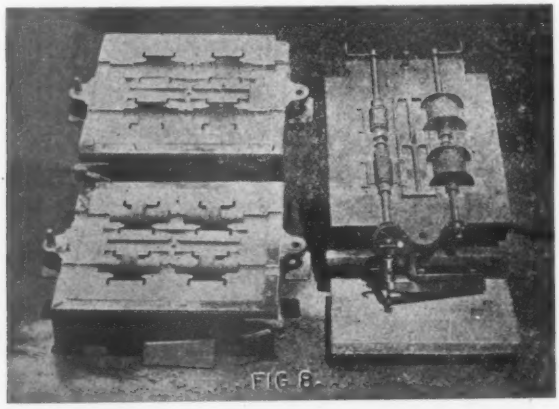


Fig. 2 is a mold made from this machine with all the cores set in position. Fig. 3 is the machine to make the cope part for this mold. It is exactly the opposite shape. Fig. 4 is a mold made from this machine. The flask for the drag part is made with only a few bars to strengthen it, and when rammed up it is clamped to the machine, the whole being lifted up and rolled over by means of trunions attached to the machine. It is then set down, the pattern raised, the machine lifted off, rolled back, and ready for another. The cope part is barred up very carefully in order to save trouble in setting gaggers, which are usually very few. Fig. 5 is a wheel molding machine for forming the drag part. Fig. 6 is a mold made from the cope part of this same machine. Fig. 7 is a stripping plate machine of a very simple but ingenious design which can be used to make almost anything of a circular nature.

At one time I observed a machine which suggested several ideas to my mind and with which I have made some very complicated castings reducing their cost fully 25 per cent. and giving perfect work. You will observe that there is only one pin in the plate, one pin in the cope and one in the drag, for this machine we use a well-made snap flask with the holes absolutely perfect.

The flask is made of good seasoned lumber. The pins are turned of tool steel. The plates are planed all over. The sides are planed parallel to each other in order to divide the patterns equally. Grooves are cut into the plate half the depth of the core. A spindle is used the exact size of the core, which serves as a core print, except when in large cores a coreprint is turned up with the pattern. The greatest difficulty in making this machine was to get all the patterns absolutely the same in order to have a perfect duplication. This difficulty was got over by our patternmaker who designed a very simple but ingenious contrivance which is attached to the tool holder of the turning lathe, an illustration of which is reproduced in Fig. 8, showing the tool for inside work, and in Fig. 9 which shows the tool for outside work. We are now constructing a large number of these machines, a great advantage of them being the fact that we only use one plate, and there is no need of the expensive stands and levers. You simply

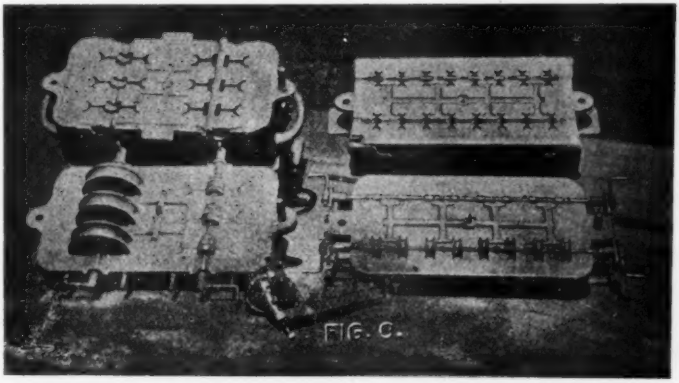


FIG. 8.

place the machine upon a regular snap bench. The object in using snap flasks is that it saves a large amount of stock flasks; they also are much easier to shake out after being cast. We have endeavored to keep all plates as near as possible the same size so that any flask will fit them.

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NOTES ON THE MICRO-STRUCTURE OF CAST IRON.

BY PERCY LONGMUIR, SHEFFIELD, ENGLAND.

Instances are occasionally found where metal of the right chemical composition goes wrong in practice. It is in cases of this kind that the real value of microsopical examination is most evident, for very often such an examination will locate the trouble and at the same time suggest a remedy. Naturally an examination of diseased samples can only be undertaken after a thorough study of healthy ones, hence a foundation for the study of abnormal samples must necessarily be based on the knowledge gained from a wide series of normal ones, that is, samples of known chemical composition and known physical conditions.

The structure of cast iron is very complex—far more so than that of steel—a fact readily shown by the high content of elements present other than iron. By polishing and etching a sample of cast iron, several of the compounds of the elements with iron are, under suitable magnification, rendered visible. The structural features such as the arrangement and distribution of the various compounds and their relationship to each other can then be readily noted and the effect of this combination on the mass then becomes an estimable quantity.

If the metal under examination contain no impurities it is evident that its mass will be built up of pure crystals. A section cut from such a pure metal will after polishing and etching show only the crystal junctions. Crystal junctions of this type are shown in Fig. 1, which represents the structure of almost pure iron. Even here, although the metal is so pure, the very minute trace of carbon present can be readily detected in the dark knots of which about a dozen are to be seen. As foreign elements are added to pure iron the structure becomes more complete and a point is reached when all the pure crystals are replaced by more

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complex ones. It is to be remembered that all grey irons contain appreciable amounts of two varieties of carbon, silicon, manganese, sulphur and phosphorus. Of these elements graphite is present in its elementary form, that is, as free carbon. The remaining constituents are present in compound form associated

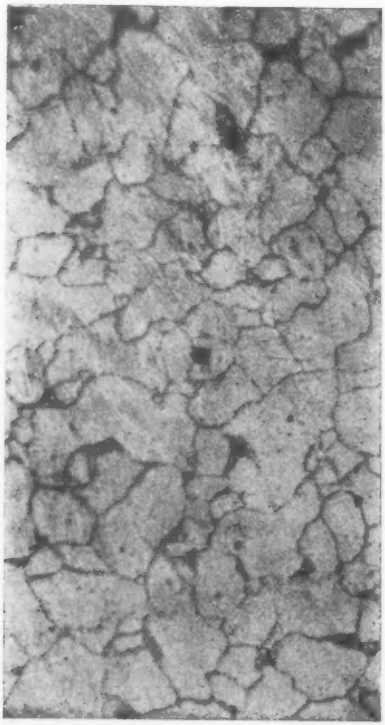

Fig. 1. Magnified 360 diameters.

Carbon	0.03	Sulphur	0.01
Silicon	0.02	Phosphorus	0.01
Manganese	0.07	Iron	99.86

either with iron or with other elements. Thus sulphur may occur as sulphide of manganese or as iron sulphide. Carbon occuring in the combined form is present as a definite carbide of iron; or under certain conditions as a double carbide of iron and manganese. Phosphorus is associated with iron as a definite phosphide. These compounds are all distinguishable under suitable magnification, but the association of silicon and iron is, so far as present knowledge goes, unrecognisable.

Microscopically these constituents have received other names— for instance pure iron is known as "ferrite," hence a structure similar to that of Fig. 1 consist almost entirely of ferrite. Combined carbon receives the term "cementite" and a mixture

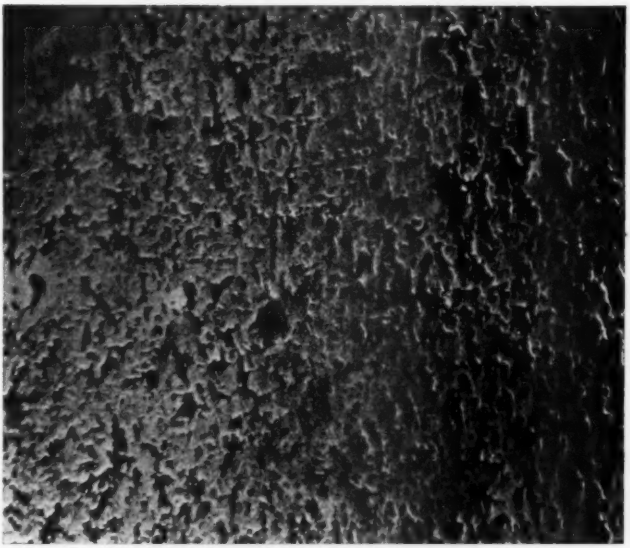

Fig. 2.	Magnified	60 diameters.	
Combined Carbon	0.54	Manganese	0.63
Graphite	3.11	Sulphur	0.04
Silicon	1.77	Phosphorus	1.34

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of cementite and ferrite is known as "pearlite." Pearlite often consists of alternate striae of cementite and ferrite and in such a form gives a magnificent play of colours resembling those of

Fig. 3. Magnified 460 diameters.

mother of pearl, consequently this constituent was named by its discoverer, Dr. Sorby, the "pearly constituent" a term now contracted to "pearlite."

The classical researches of Professor Arnold have conclu-

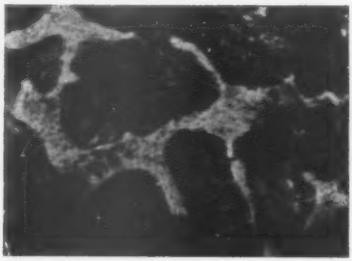

Fig. 4. Magnified 360 diameters.

sively shown that iron containing 0.89 per cent. carbon consists entirely of pearlite. As the content of carbon increases above 0.89 per cent. structurally free cementite appears increasing in quantity with each increment of carbon. It therefore follows that a white cast iron will consist essentially of cementite and pearlite. In the majority of grey irons used in the foundries the combined carbon is well below 0.89 per cent.—cementite is therefore only present as a constituent of pearlite.

Sulphide globules when in the form of manganese sulphide show a light grey color, whilst iron sulphide shows a light brown tint.

In high sulphur irons the sulphide tends to envelope the crystals—a section cut from such an iron would show a network of sulphide following the crystal junctions and destroying their continuity. These sulphides have been thoroughly investigated by Professor Arnold whose researches have thrown much light on

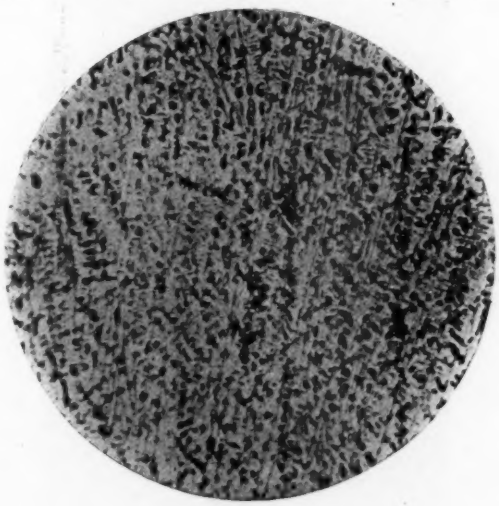

Fig. 5. Magnified 50 diameters.

Combined Carbon	3.25	Sulphur	0.41
Silicon	0.78	Phosphorus	0.06
Manganese	0.09		

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the behaviour of both iron and manganese sulphide.

The relations of iron and phosphorus have been very thoroughly studied by Mr. J. E. Stead. In September, 1900, Mr. Stead presented before the Iron and Steel Institute a most exhaustive research on this subject. With ordinary pig irons the phosphide of iron appears to be rejected to a eutectic of uncertain composition. Eutectic may for our purpose be defined as that portion last to solidify. This phosphide eutectic may be readily distinguished in all gray irons by an ordinary etching medium, but in white irons containing structurally free cementite, Mr. Stead's "heat tinting" process becomes necessary to distinguish the eutectic from the cementite.

Fig. 2 reproduces a photo-microscope of an unetched section of grey iron at a magnification of 60 diameters. This magnifica-

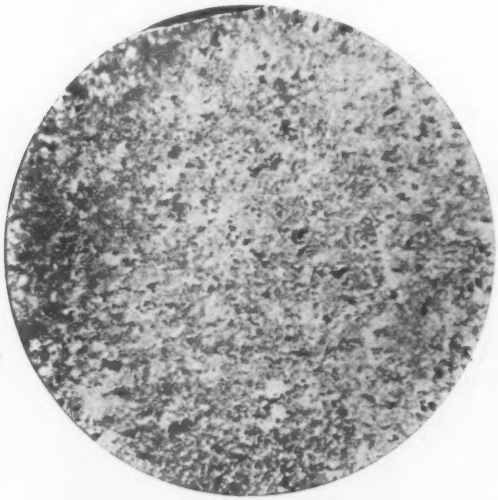

Fig. 6. Magnified 50 diameters.

Combined Carbon	0.82	Manganese	0.09
Graphite	2.07	Sulphur	0.37
Silicon	0.75	Phosphorus	0.07

tion gives as it were a general view only—to get at the ultimate structure higher powers must be used. Fig. 3 represents the structure of an ordinary grey iron magnified 460 diameters. The larger portion of this field consists of pearlite embedded in which are irregular areas of the phosphide eutectic and several notable black plates of graphite. The phosphide eutectic is recognisable by its irregular shape and broken up structure, an area in the cen-

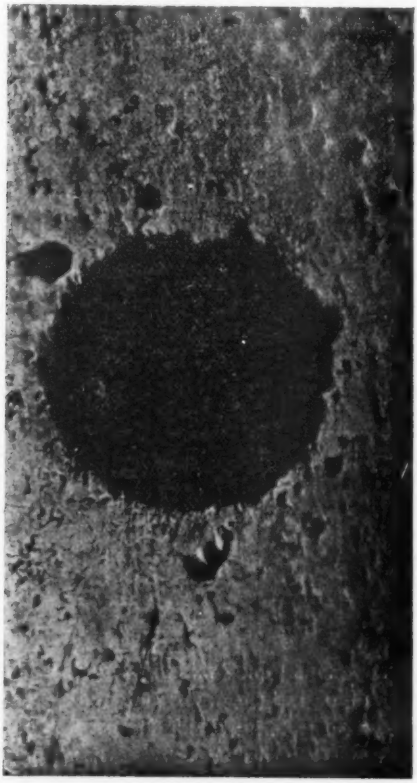

Fig. 7. Magnified 60 diameters.

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tre of the photograph enclosing an area of pearlite is worthy of notice.

Fig. 4 reproduce an area of phosphide eutectic from the same section as Fig. 2.

A typical white cast iron consisting essential of pearlite and cementite is shown in Fig. 5. This is a type of iron used as a base for the production of malleable cast iron.

The influences of annealing is shown in Fig. 6, which represents the same iron as Fig. 5, after going through the ordinary malleable iron annealing in ore. This section consists essentially of pearlite and graphite—the analyses appended to each figure showing the charge in carbon condition. For the loan of the negatives illustrating figures 5 and 6, the writer is indebted to the courtesy of Mr. T. Baker B. Sc.

Quite a part from the clear light thrown on what has been aptly termed the internal architecture of a metal, microscopical examination reveals many other features of profitable interest, one notable feature being the examination of minute flaws. Space will not permit of many illustrations under this head, but figure 7 reproduced from a photo-micrograph of a pin hole in the same section as Fig. 2, will show the range of possibility in this direction. Obviously a study of flaws of this character offers much to the founder producing castings which have to meet a hydraulic or high steam pressure test.

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FOUNDRY CONTROL.

Is it an Advantage to a Foundry to place the Cupola and Metallurgical Operators under the control of some one other than the Foundry Foreman?

BY ROBERT P. CUNNINGHAM, HOLYOKE, MASS.

In my opinion the responsibility for the conduct of a foundry should not be divided and the chemist should either be placed under the foreman or the foreman should be subject to orders from the chemist. I think that the best results are obtained where the foundry foreman is at the head and everyone in or about the shop is under his control. This is due to the fact that there should be only one person to look to for orders. When the responsibility is divided it is always the other fellow who is to blame whenever anything goes wrong. Again a set of shop employes are more apt to lose their respect for the foreman when they find out that someone else has anything to say about the management of the works, when they are inclined to look for authority from the quarter that promises them the most privileges. No body of workmen can be governed by two persons any more than an army can be successful if it is commanded by several generals, each having the same power. No two men can think alike in all things, and for these reasons I claim that a founday foreman should have full control of the foundry and be given full power to manage it as he deems best and to him should be given the credit for its success or censure for its failure.

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THE CONTINUOUS OPERATION OF THE IRON FOUNDRY.

BY JOHN C. KNOEPPEL. OSWEGO, N. Y.

In writing on this subject the writer desires to be understood as not being antagonistic to the continuous operations of our foundries, recognizing as he does, the general progress of the trade in this country, as well as the inventions brought out to develop and cope with the demands for castings to meet the requirements of our customers. The fact cannot be contradicted that the foundries in this country are entering into an era of improvements and facilities gigantic in their proportions.

All of this naturally suggests to the advanced founder that the most economical ways and means to secure the best results are to operate the foundry continuously. In giving my views on this important subject I write from the standpoint of a practical molder and foundryman of over thirty years' experience in all lines of castings, and will at the outset make mention of several features that we as foundry managers should give careful and thoughtful consideration.

1. Do the present conditions of the foundry business warrant the operation of the foundry on the continuous plan? 2d. Would this be to the best interest to the foundrymen in general from the point of view as a paying investment? 3d. Would the expendi-

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tures necessary for the continuous operation of the foundry give adequate returns? 4th. Would the output be of a better quality? 5th. Would not the continuous working of the foundry tend to increase the wear and tear of machinery tools and maintenance? 6th. Would the continuous operation of our foundries be beneficial and healthful to the workman and his family? 7th. Would it not become monotonous and tend to retard general progress, rather than to increase it by the environments, being a sameness from day to day, and have a tendency to decrease the capacity and ability of the molder and mechanic? 8th. Would it not have the effect to decrease the qualifications and skill of the individual man and molder by this continuous work, and constant humdrum of foundry life, and thereby lessen the ambition of the young man who enters the foundry as an apprentice with the view of becoming a molder and a mechanic? 9th. With the present supply of help, both molders and general laborers, can the foundry be operated on a continuous basis successfully when we consider the scarcity of all classes of labor, the rate of pay, and the demand and supply of work, all of which govern the successful operation of a foundry?

When we consider the present times and the general progress the foundry has made during the past ten or fifteen years, it is no wonder that many are inclined to the idea of operating a foundry on a continuous plan as being the most economical as well as profitable way of obtaining the best results and greatest returns. This subject is a very natural one and timely when we consider the enormous trend of business and the close competition in our products, taking into account costs, together with the possibility of a shorter working day and the desire of the molder to curtail his output. Under these conditions would the continuous operation of the foundry be profitable? As managers of foundries we are asked to pay an honest day's wages and in return we expect to obtain an honest equivalent of work per day. Do we obtain this and can we as foundrymen get it at all times? Are we not handicapped in many localities and forced by circumstances to hire men who are not capable and in this way increase the cost of our product and output? As foremen and managers our mission is to operate the works under our control so that we may give to our employers a fair interest on the money he has invested.

Under some conditions as they exist at present we might be led to believe that a continuous operation of the foundry would be the best plan to follow in order to obtain the greatest returns. In order to answer this question intelligently it seems to me that the first thing to ascertain is whether present conditions would warrant this. In a general way the writer is inclined to the opinion that they are not favorable. In the continuous operation of a foundry the wear and destruction of machinery and tools would be greater in proportion, than under the present plan of operation, for by continuous working the time for repairs would be limited.

Again would it be to the best interest of the foundry business in general, considering the expense and outlay of capital, to encourage this plan of operation? Are we as foundrymen prepared and physically able to cope with and handle the work if allotted to us, and can we stand the strain of responsibility included in the management of a foundry on the continuous plan? The writer finds that the foundryman of today in a progressive shop has his hands full to keep up his end and come out ahead at the end of the year.

Further, would the output of a foundry be of a better quality than it is under the present methods of operation and condition? Where large bodies of men are employed we find it a difficult matter to keep and hold steady men, and the more we have to employ the worse will this evil become. Then again where the same work has to be continued and performed by different shifts of men this does not always result satisfactorily and would consequently give more chance for mistakes and loss to the foundry.

It is also likely that continuous work in the foundry would be injurious to the health of the molder, as the fact remains that a molder working by natural day light and under normal conditions can perform his work to better advantage and with less percentage of mistakes and loss than occurs where a foundry is working under a continuous plan or with two or three shifts of men.

The continuous operation of an iron foundry on general principles is not productive of the best results in molding and castings for the reason that the work is not performed as uniformly well as under present systems, where the men are in much better condition to perform their work, and labor with greater zeal and ambition and consequently obtain better results. Continuous work is irksome and

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tiresome to the individual who needs his normal rest to reinforce him for the next day's labor, and the proper time to obtain this is during the night.

There would also be a tendency for other disturbing elements to arise, and mistakes would be liable to happen more frequently where two or three shifts of men are employed. The constant hustle and bustle in foundry work during the molding and casting, where this takes place at the same time, would naturally detract the attention of the men from their work, and as such would be the means of producing mistakes and accidents. An increasing number of patterns and flasks would also be required as well as a larger force of molders and helpers.

While the melting might be done continuously to accommodate the changed conditions there will be a tendency to increase the cost of repairs, and the installation of additional cupola capacity would mean further expense and the employment of more help. There will be bound to be more or less confusion where a large quantity of metal is being melted and handled and the foreman would require assistance to keep things moving in the right direction. In view of this increased cost of production will it pay to arrange and fit up our foundry to run continuously? In case of break downs, shortage of work or delay of any kind there will be losses which would materially increase the cost of the output.

There is no question but that there will be an increase of foundries operated on the continuous plan, but in a general way it is doubtful if the majority of us are prepared to take up this question at this time. The shortage of molders and coremakers has put the majority of the managers and foremen of foundries in a serious predicament and the introducing of continuous operation of foundries at this time would no wise remedy existing troubles. To overcome the shortage of capable men we are putting in molding machines and the very best improvements that can be secured, yet, it is to be remembered that before molding machines can be worked, men must be found to handle them. I believe we have a sufficient number of foundries in this country to handle all the business that has to be done under our present methods and conditions. Where foundries are being operated continuously and successfully it will general be found that the product is under their own control and is being duplicated by the thousand. The demand which has existed

for castings for the past four or five years is not likely to be with us always. What we need more than anything else is the proper management of our works, so that a larger output can be secured per man. This can best be accomplished by constantly keeping the molder employed during the day and providing him with the proper tools and supplies in time.

It has been my experience that mistakes are largely due to work being performed on the same job by a number of men, or by different shifts of men. I have yet to see a molder who does not prefer to do his own pouring, and to my mind a very large number of castings, no matter how well the molds are made, can be and are lost through improper pouring, and so it is where more than one party is engaged on one job, the blame and responsibility is always shifted to the other fellow, and hence the responsibility of the individual molder is lessened. No doubt the continuous operation of our foundries will be in line with future progress and shorter hours, and the reconstruction of foundry methods, but all of this is a new development upon which further education must be had for both employer and employè.

I am of the opinion that a much larger field is in store for the molding machine in the future, partly, on account of the scarcity of molders, which forces the manufacturer to avail himself of every practical invention brought out to reduce the cost of his castings. I have always found it a good investment to have the men out of the shop in time as they are then in a better mood and condition to resume their labors next day. In shops making it a practice of being late the men in general do not take kindly to this and we cannot blame them for it. Where the molders know that they will get home in good season, they will be more ambitious to accomplish their work on time and I prefer to allow them to go home when they are through casting. In my judgment it is poor management to keep the men sitting around in wet clothing waiting for quitting time, and I find I can get more work out of them by treating them like men and be reasonable in all things. It is not always possible to leave the shop on time and where such is the case I find they are willing to help out when they know the circumstances. In my opinion the manager of a foundry does not have to exact the last minute's service from an employee in order to make money for his employer.

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A NEW CUPOLA SLAG CONVEYOR.

BY THOS. D. WEST, SHARPSVILLE, PA.

In melting over 50 tons in cupolas of above 50 inches inside the lining, there is more or less slag formed which must be taken from the cupola. Some founders allow this slag to accumulate below the slag spout, while others prefer to convey it some distance away. To do this the slag is often let run down a sand or iron runner as far as it will flow, and is then pulled with a hook the balance of the distance, while in a semi-molten state. Other founders allow the slag to run into small buggies which can be handled by one man. Again the slag may be let run into a car which is sent to the dump pile over regular track.

Believing that present methods could be improved, that money could be saved, besides doing away with disagreeable labor and aiding our continuous melting system, we decided to install a slag conveyor as shown in Figs. 1, 2, and 3. This conveyor was gotten up by the C. O. Bartlett & Snow Co., of Cleveland, Ohio. While it might be thought a rather elaborate and costly machine, nevertheless, as we are making radical changes in our methods of molding and casting, and are arranging for continuous melting of 20 to 22 tons per hour, or 480 to 528 tons daily for each week's steady run, when using hot metal from the blast furnace, we consider the machine a good investment.

In operating the slag conveyor, the belt "B" serves to start and stop it. The slag as it runs from the cupola flows down the spout "C" into the buckets "D". The buckets convey the slag outside the shop, dropping it from them at "E" in solid form, into the car, cart, or pile "F". The blocks, after they are sufficiently cool, may be broken up to pick out the iron which has been carried out with the slag. We have a method in view which contemplates

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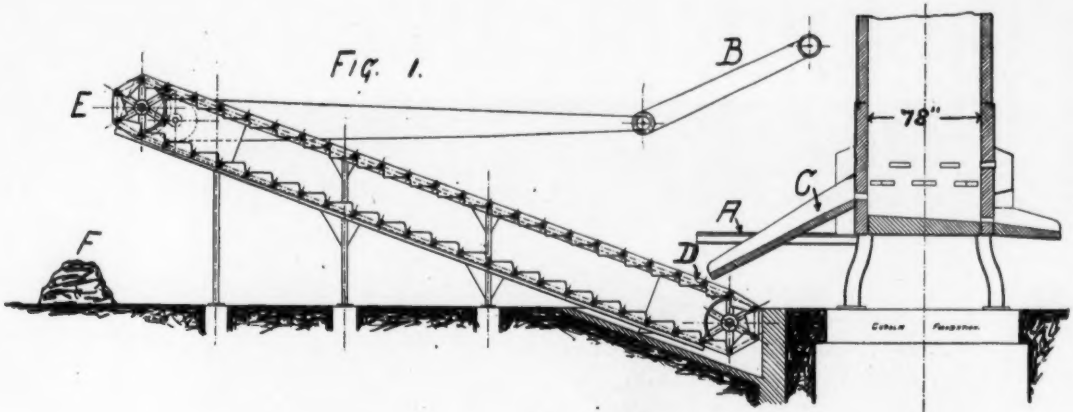
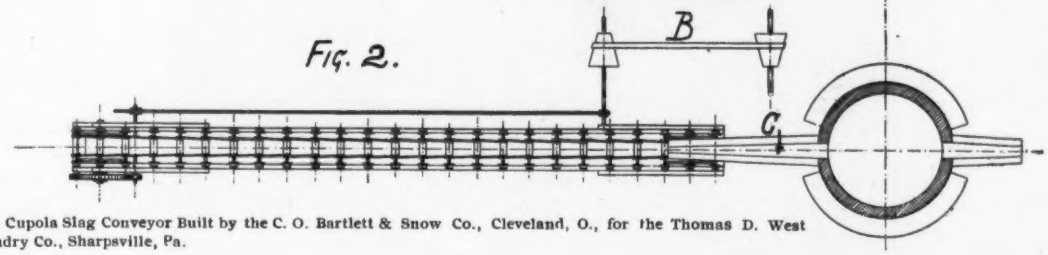
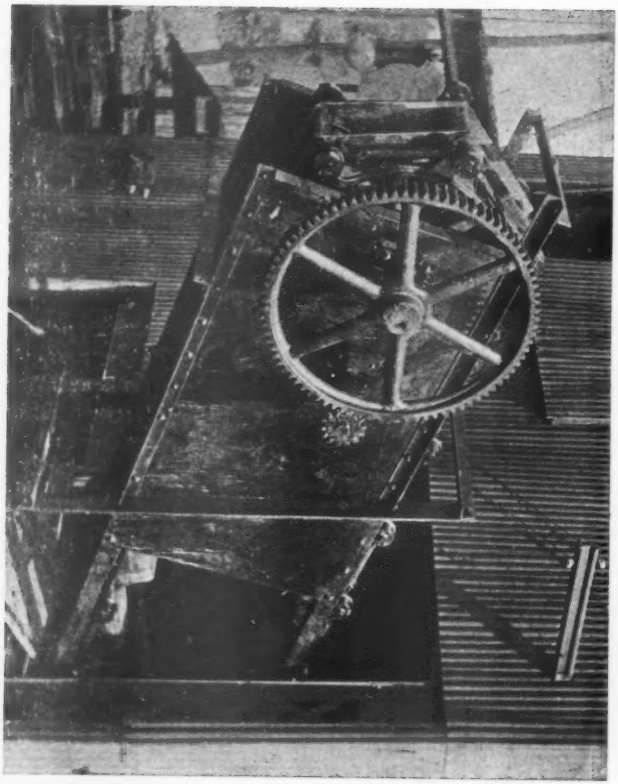
gathering the iron before dropping the slag into the car. This will then save the labor connected with the slag question in any form.

When it is considered that slag may contain shot iron up to 4 per cent. as well as an oxide of iron equivalent to 15 to 20 per cent. of the metal, aside from what iron may run out over the slag hole, the importance of gathering all the metallic iron possible may be seen. Then again, as the amount of slag produced is about 30 to 50 lbs. per ton of iron melted, the slag made by our projected daily heats would be 19 to 25 thousand lbs. From which the importance of the new slag conveying system we are installing may be readily judged.





Cupola Slag Conveyor Built by the C. O. Bartlett & Snow Co., Cleveland, O., for the Thomas D. West Foundry Co., Sharpsville, Pa.



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FOUNDRY RESPONSIBILITY.

Shall it not begin in the Designing Room?

BY F. W. STICKLE, JAMAICA PLAIN, MASS.

By the usual methods followed in our manufacturing establishments if a new machine is to be designed it is many times given to a technical man who never was inside of a real foundry a dozen times in his life. He has no knowledge of the difficulties the foundryman has to contend with day after day and he proceeds to make a picture of the machine, which suits his taste, in utter disregard of the difficnlties which may later arise in the construction of his design.

When the details have been attended to in the drawing room, the drawing is sent to the pattern shop where the boss patternmaker gives it to a workman to attend to, and it is not at all likely that there are two workmen in the pattern shop who will make a pattern the same way. Up to this time there has been no limit placed upon the expenditures, there has been but little thought given to its cost, and no expert judgment used in general. As soon as the pattern reaches the foundry cost keeping begins, and the general quality and fine appearance of castings are noted. Here is where the foundryman's troubles start, as possibly the design should have been made into a master pattern, from which a metal pattern should have been cast to obtain the best results at a reasonable cost, but no one has ever given this feature a thought and of course it is out of the question to go back and make another pattern, so the man in the foundry must use the pattern as it is at the cost of his reputation and be eternally abused because the castings are not as they should be.

Slight variations in the lines of design or a few alterations in the construction of a pattern will simplify the most complicated job

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so that it will be a pleasure to turn it out for both the foundryman and engineering department, and if these things had been considered in advance the outlay of much money could have been avoided. Another very important thing in the making of patterns of a similar type is to fit these up so that the rigging in hand can be utilized instead of having to make new and expensive preparation for every new pattern which comes along. A further factor is the equal distribution of stock to avoid shrinkage, strains and sponginess. As a rule, patterns that can readily be cored are left to be drilled, while others are left to be cored just where this adds risk and labor amounting to far more than the stock removal would cost, should the core be omitted. In the jobbing foundry these conditions are met with almost continually and it is a common charge that no two foundrymen want a pattern constructed alike; admitting this to be the truth, if pattern makers ever made two patterns alike, perhaps the foundryman would be able to establish a right way of doing things also.

Another feature I have found in some manufacturing plants, and which I have never been able to understand, is that the foundry is expected to break up a well regulated big floor any time the machine shop thinks it needs a different casting, and it matters not if there are three hours molding time lost and half a dozen laborers employed in making the change. After all this trouble it very frequently happens that we find this same casting lying around the shop for a month unused. There is no place where the interfering with the regular day's work means more in the increase of cost than in the foundry. Many a time have I found myself wanting a small job done in the machine shop, which was very important, when I have been informed that they could not stop to change a machine until the job it was doing was finished, and this too when the work was only suspended on the two centers of a lathe with a dog attached. I am sure it could have been taken out in one minute without any assistance. I simply want to call attention to these facts for the consideration of our friends who are devising red tape schemes to reduce foundry costs. I will further add that the excellent results obtained from our molding machines are more due to our system of not interfering with them than to the actual capacity of the machine itself, and why should we not give due consideration to our mechanics as well as our machines?

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TECHNICAL EDUCATION FOR THE FOUNDRY OFFICE.

BY JOHN G. STEWART, BIRMINGHAM, ENGLAND.

Never in the world's history has there been such a demand for technically trained men as there is at the present time. It is essential that the engineer and mechanic be so trained. In an engineering establishment of any proportion the commercial department is often divided under different heads, each of which is in charge of a clerk having a knowledge of that particular branch of the business.

Taking our own branch, "Iron Founding," is it enough that the commercial or office staff be acquainted with office routine only? My contention is that the office-man should, in addition to the office routine, possess a thorough knowledge of the requirements of a foundry, and know the use of all foundry materials, stores, and tools. Let foundry-clerks take an interest in and make a special study of the ins and outs of a foundry, obtaining as far as possible a grasp of the intricacies of the trade, and the friction (often created through ignorance) between foundry and office will be less prevalent.

I advance this suggestion and hope it will provoke discussion; may it be a means of setting the machinery in motion to provide facility for the obtaining of a sound technical knowledge and a good idea of the practical working of a foundry for those young men in foundries who hope to become expert accountants in this branch of the iron industry.

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THE HEATING AND VENTILATION OF FOUNDRIES AND MACHINE SHOPS

BY W. H. CARRIER, BUFFALO, N. Y.

The great slogan of this industrial age is economy, and manufacturers of today are deeply interested in all impovements tending in that direction. Although improved methods are constantly decreasing the cost of manufacture, competition is becoming more keen and the wage scale is increasing. As a result increasing attention is being given to securing a maximum efficiency of the workman. To this end our shops of today are being better built, better heated, ventilated and lighted than ever before.

It is the purpose of this paper to set forth in as concise and complete a manner as possible; first, the nature of difficulties to be overcome in the satisfactory heating of shop buildings, and second to show the adaptation of the fan system to the solution of these difficulties.

Although machine shops and foundries are perhaps the simplest type of building, yet the problem of their successful heating is one of the most difficult.

Heat losses occur in the building from two causes: first by the direct transmission of heat by radiation through the walls and exterior surfaces of the building, and second by the infiltration of cold air from without. In designing a heating plant, the first of these losses may be very accurately determined by referring to tables which have been prepared showing the amount of heat radiated under different conditions through various thickness of walls, windows, doors, roof, etc. The heat lost through infiltration varies so greatly in various sizes and construction of buildings that no definite rule can be given. The allowance to be made for this is

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necessarily a result of experience and a careful test of previous installations.

In either fan or direct radiation systems difficulty is liable to be experienced from the heated air immediately rising and forming a stratum of heated air just beneath the roof. In machine shops and foundries owing to their height and to the great amount of sky-light surface which is always provided in the best modern construction, the loss occasioned by this action of heated air may be considerable, and its prevention is a serious problem. In direct radiation, since the air currents are produced entirely by heating, the loss in this way is very great, and cannot be prevented. Practically the only way by which any useful effect from this heated air can be realized is by placing the coils next to the wall near the floor and allowing the heated current to pass upward along the walls; but even this is wasteful from the fact that it heats the walls unduly. With the fan system, however, the distribution of the heated air is entirely mechanical and affords an opportunity for utilizing its heating effect to the very best advantage. Various methods of distribution have been devised with the fan system whereby the effect of a rising current of heated air is almost entirely avoided. These systems, in general, depend upon securing a perfect diffusion of the heated air along or near the floor line and will be described in detail later.

A second difficulty experienced in high buildings, such as machine shops and foundries is the effect due to outward leakage of the heated air at the upper part of the building and consequent inward leakage of cold air along the floor line. This leakage is produced by the unbalanced pressure of the columns of heated air within the building, and that of the cold air without. The effect is in principle precisely that of a chimney. The difference in pressure produced can be measured in inches of water, and increased in direct proportion to the difference in temperature between the air within the building and that without. Since the flow of air is proportional to the square root of the pressure, the amount of air entering or leaving the building through leakage will be in proportion to the square root of the difference of temperature. The effect of this leakage is as evident in theory as it is noticeable in practice.

The air which escapes from the building is naturally the very hottest and therefore has not had its heat fully utilized; while that

which enters a long the floor chills the airat the lower part of the building very noticeably, forming a cold layer of air which cannot be removed except by some means of positive circulation or diffusion with heated air as secured by the fan system. In large machine shops and foundry buildings this layer of cold air may frequently be found to extend from 4 to 6 feet above the floor, while the amount of heat lost due to the high temperature in the upper part of the building may be much more than sufficient to secure satisfactory heating effect throughout if properly applied. The most effective remedy for this evil is to maintain a slight pressure within the building by means of a fan which takes a portion of its air from without.

A third difficulty presenting itself in buildings covering large area and having a large amount of skylight is the cold down draft, which the cooling effect of the skylights has a tendency to produce. In very wide buildings where heat is distributed only along the walls this effect is noticeable, and as it comes directly upon the heads and shoulders of the workmen, and is in the part of the building most used, it is very objectionable. However, with the fan system it can easily be remedied by causing a flow of heated air toward the center of the building.

In general buildings may be heated in two ways: First, by keeping the walls and roof warm. This is accomplished in direct radiation system by placing coils along the walls, and in the fan systems by blowing the heated air toward the walls. A second method is to heat the air within the building directly. This can be accomplished in a satisfactory manner only by an indirect or fan system. Of these two systems it may be said that if either is used exclusively, the second method is preferable, since it is the more economical. In the first method it is quite evident that if the walls be kept warm, radiation will not occur to any great extent from the interior of the building, and the heating effect will be satisfactory. On the other hand it is equally evident that the radiation through the walls caused by heating them to a higher temperature occasions a much greater radiation loss than would occur if the room temperature had been secured by heating the air directly. Since the heat transmitted by wall coils is chiefly direct radiation, the loss occasioned by the direct transmission of heat through the walls with this system is very great and may be as high as 25 per cent or more of the total radiation.

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SYSTEMS OF AIR SUPPLY AND DISTRIBUTION.

With the fan system the method of supplying and distributing the air in the building is the consideration of chief importance. The usual methods of supplying heated air are, first, where the air is taken entirely from without doors and is forced directly into the building through distributing ducts. This method is generally know as the Plenum System, and the pressure produced in the building causes a continuous exit of air from the building, either through the natural openings, as is usually the case in factory and other large buildings, or through special vent openings provided for the purpose, as in public buildings.

A second, and more common method for shop buildings where forced ventilation is not a necessity, is to draw the supply of air entirely from within the building and again forcing it through the distributing ducts. This causes a continuous circulation of the air within the building, and when properly applied secures excellent results.

The first of the above methods has the advantage of securing an excellent ventilation, and in the instance of foundries this is often desirable. Another advantage possessed by the Plenum system is that it produces a continuous outflow of air through all the crevices and openings in the building which would otherwise be admitting cold air from without to set along the floor and prevent satisfactory heating. In buildings of loose construction this is frequently the only system which can be successfully operated.

The air return system often has an advantage over the Plenum system in that all the heat supplied to the air is effective in heating the building, but does not possess the advantage of producing a plenum in the building.

The ideal system is a combination of the plenum and return systems and should always be used where possible. In this system the great portion of the air is returned to the apparatus, but sufficient air is continuously taken from without through a fresh air connection to create a plenum within the building and prevent the inward leakage of the cold air along the floor. In this manner the natural leakage is supplied—not by in-flow of cold air through the crevice around the doors and windows—but by air passed through the apparatus and heated to an effective degree. This system has

been found by test to be more economical than air return alone. The proper amount of air to be introduced from without is determined by securing a point where the noticeable inward flow of air around the doors or window ceases. If the plenum is carried beyond this point there will be a loss due to unnecessary heating of the outdoor air.

SYSTEMS OF AIR DISTRIBUTION.

There are several systems of distributing the supply of heated air A method usual in public and office buildings and sometimes employed in factory buildings is the vertical duct system by which the air is admitted through vertical ducts or flues built in the walls at a point about eight feet above the floor. Suitable openings are supplied at the floor line for the air that is forced out. By this method the air is continually forced downward as it cools and the cold air is always removed at the floor line. A method of distribution quite similar to this is one where the air is first blown into brick ducts placed underneath the floor. From these ducts vertical galvanized iron risers are arranged along the walls. These are so arranged as to blow down-ward and away from the wall at a height of about eight feet from the floor. These outlets should be adjustable so that in case too direct a draft is caused in any portion of the building the outlet can be diverted in some other direction where the air current will not be objectionable. This method is well illustrated in the Locomotive Repair Shops of the New Jersey Central, at Elizabethport, N. J. The general arrangement may be seen in the accompanying illustration.

This system is also frequently very successfully employed in foundries. Advantages of this system are: first, that there is no overhead piping in the way of cranes, etc.; second, that the greater portion of the distributing ducts are brick and are not subject to deterioration; the third, and principal advantage is, that the air can be distributed by this means where most needed. This system is sometimes somewhat modified by placing the outlets close to the floor and blowing downward directly along the floor. This secures

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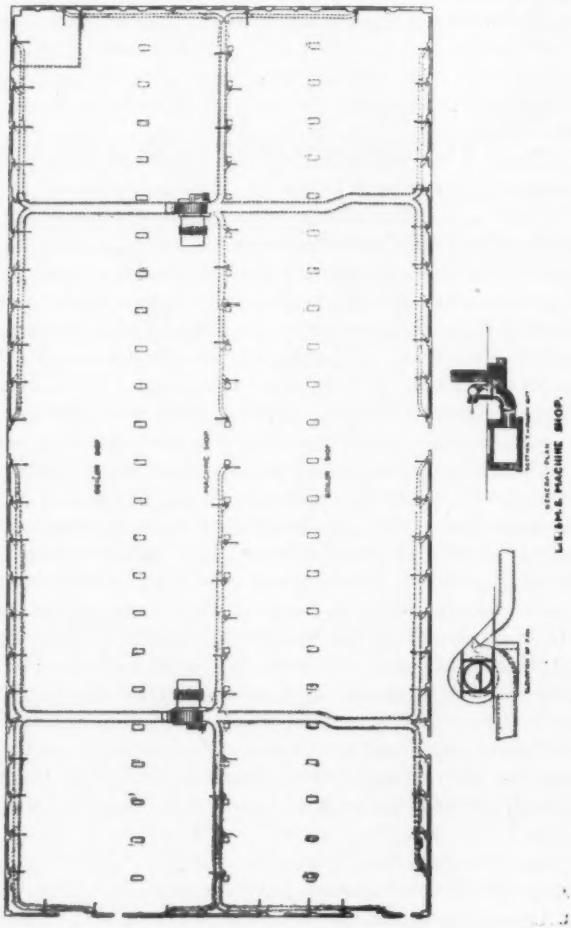
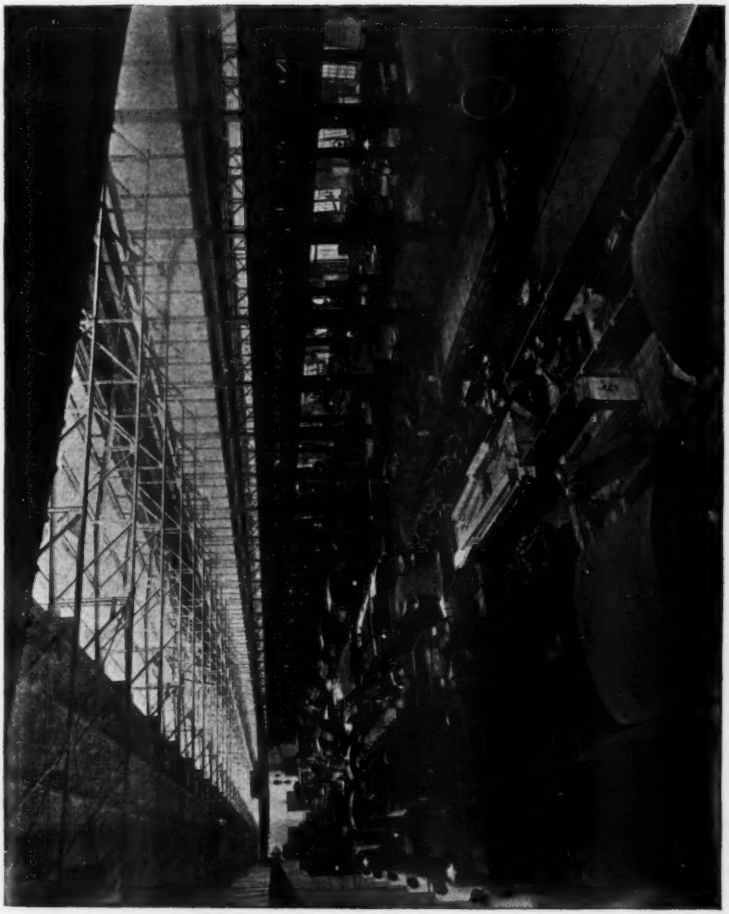
a perfect diffusion of the heated air at the floor line, and avoids any drafts which would be objectionable. A good example of this type of installation is shown at the Lake Shore & Michigan Southern machine shops, at Collinwood, Ohio. The general arrangement for

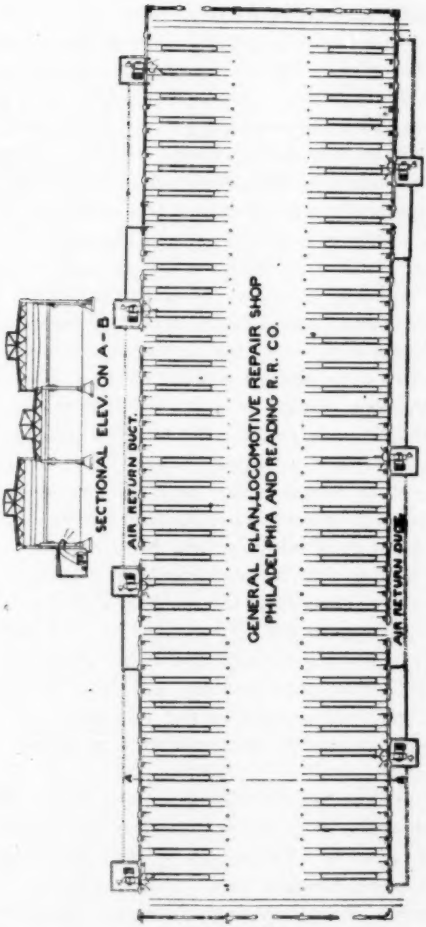




air distribution is shown herewith. It will be noted that the apparatus consists of two duplicate sets placed in the center of the building, and that a line of distributing ducts is placed around the entire building with an additional distributing duct running from the center of the building. This was necessary on account of the great width of the building which consists of three shops united in one.

Another system which has proved very satisfactory is that in which a distributing air return duct is employed. This approaches very closely in principle to the plenum system used in public buildings and is a combination of both plenum and exhuast systems. This may be best described by referring to the heating plant at the Philadelphia & Reading Shops, at Reading, Pa. In this instance, instead of employing one or two large units, seven separate sets of apparatus have been provided, placed in small fan houses built at intervals at either side of the building. The peculiar feature in this and similar installations is that no distributing ducts or piping for the heated air are used; the air being blown directly into the building at about 8 or 10 feet above the floor through an outlet branching in three directions, and through which the air passes at a comparatively high velocity. The distribution is effected entirely by the return vent ducts which are distributed at frequent intervals along the walls as shown in the accompanying figure. These open into large return air tunnels which are provided on either side of the building and serve the additional purpose of affording a convenient place for locating steam and water mains, and also electric light and power mains. Provision is made for taking a portion of the air from without doors to secure a plenum. One great advantage of this system is that it removes all cold air leaking into the building at the floor line as well as that produced by the cold down draft next to the walls. Further a perfect distribution is secured in all parts of the building, and the cost of installation is reduced to a minimum. In small buildings a system of distributing outlets are placed along the further side of the building, and a system of vent ducts opening into exhaust chamber are placed on the side adjacent to the fan.

Excellent results can be secured by the use of overhead piping providing it is not placed at too great a distance from the floor. The chief advantage of the overhead system is the saving in first cost, since on account of the high temperature and velocity of air


GENERAL PLAN-LOCOMOTIVE REPAIR SHOP
PHILADELPHIA AND READING R.R. CO.
AIR RETURN DUCT
AIR RETURN DUCT
SECTIONAL ELEV. ON A-B

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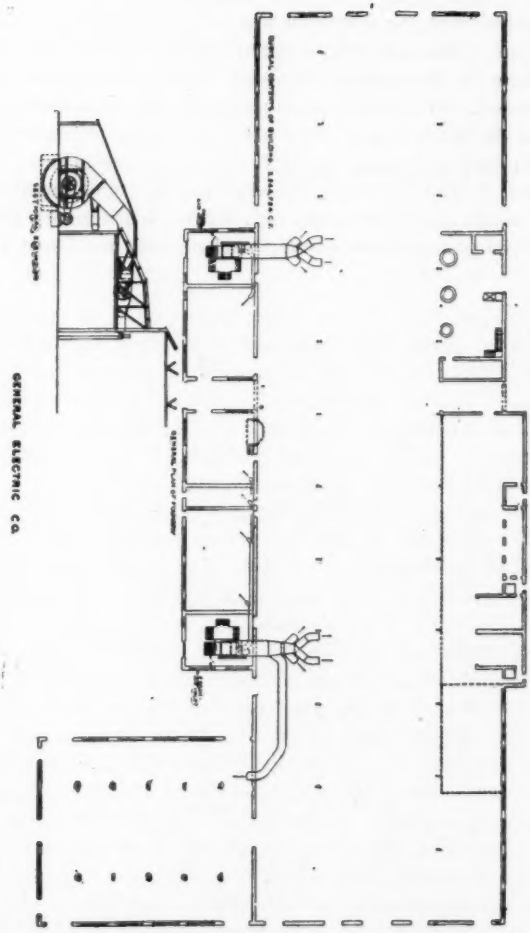
in the distributing pipes, a great amount of heat can be transferred with a very small amount of material. The cost of the galvanized iron distributing system of air ducts is usually a small portion of the total cost. The best results are secured with outlets at from 12 to 18 feet above the floor line. Above this height it is preferable to use drop pipes extending downward along the columns where they will not interfere with travelling cranes. Such a system of overhead piping is very frequently employed in foundries; although in machine shops the underground system is nearly always preferable.

In many instances a system of elaborate distribution is impracticable or undesirable. In such cases a centrally located apparatus or discharge pipe may be used. From this point the air is blown in all directions, and a circulation is produced by an exhaust connection to the fan inlet. In such instances very effective heating has been secured even where it was required to blow the air long distances. Perhaps as good an example of the successful operation of such a system may be found in the foundry building of the General Electric Company at Schenectady. This foundry which is probably one of the largest in the world is heated in an entirely satisfactory manner with a few large branch outlets. Since the plant was installed, a large addition has been built on one end of the building. This addition is satisfactorily heated by a branch inlet situated at over 200 feet from the further end which shows how thorough a distribution may be secured by a forced circulation.

Together with the advantage of the fan system in securing a satisfactory and economical heating with any desired degree of ventilation it combines a saving in the first cost, and economy in regulation, and convenience in operation to a greater degree than any other system.

The required amount of heating surface in the fan system, on account of its greater efficiency is reduced to less than ⅓ that necessary in direct radiation. This increased efficiency is due to a larger volume of air being brought into contact with the pipes than in direct radiation. It has been found by experiment that the radiation from the fan system heating surface increases more rapidly than the square root of the velocity. Hence the higher the velocity secured over any heating surface the greater will be the radiation.

With any heating apparatus a point of chief importance is the economical utilization of exhaust steam. The fan system heater on


GENERAL ELECTRIC CO.

account of its design with reference to securing the most circulation of steam. removal of air and return of condensation secures an effective operation with the minimum amount of back pressure on the exhaust line. When an engine is employed in driving the fan the effectiveness of the exhaust in heating is nearly as great as that of the live steam. Hence the cost of power is practically nothing.

That the fan system is every where becoming recognized as an ideal standard in heating method can be evidenced in no better way than by the fact that it is being exclusively adopted in all railway shops and by the most progressive manfacturers through out the country in their factory, machine shop and foundry building.

Journal of the American Foundrymen's Association.

VOL. XII. JUNE, 1903. PART I.

ANALYSIS AS A HELP TO MELTING.

BY A. W. SLOCUM, PITTSBURG, PA.

Owing to the very short time I had to prepare this paper I have confined myself to one illustration of the great help that analysis, in connection with microscopy, can be in enabling the foundryman to get maximum results in melting. From microscopical investigation can be and is obtained the knowledge as to which molecules have the most affinity for each other. Analysis would show, when best formation is obtained, of what the atoms are which compose the mass. In attempting to duplicate this formation in our mixtures we should endeavor to bring the component parts in the casting as near to their natural position as is possible, so as to obtain the largest amount of strength and durability. To do this the particles when melted must be separated as much as possible to allow a natural freeness in adjusting themselves when solidifying. If the different substances in their analysis do not show that they are composed of parts which will readily combine, when melted, you will have a weak casting and probably blame it to some one particular brand of iron, while it is really a mistake in judgment in the selection of the irons. Mixtures of this kind often give castings showing severe strains, segregations and irregular results generally, some on the hard side, and some too open, and you are liable to claim that the cupola was not working properly, that it does not bring the iron down regularly, and think that the tuyeres or something must have gone wrong. As a matter of fact it is simply a case of clannishness in the iron. The elements have simply clanned by themselves and when the proper heat was obtained and we tried to mix them up they rebelled to the best of their ability. When the struggle was over you could find some

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atoms of one element at one place, more somewhere else still adhering to their kind, some scattered around indiscriminately without regard to natural laws or the good of the whole.

Another not uncommon error is to attempt to produce castings of a given analysis by using irons all having analysis as near the one desired for the castings as it is possible to obtain. This often results in dull iron and although you know you are using enough coke, plenty of blast, you again naturally wonder if those tuyers have gone wrong. In this case your microscope would show similar formations in the different irons. Your analysis shows similar results, so that when you melt the different irons they all go down without a disturbance, there is no natural cause to disturb them, nothing to jar or separate, consequently the atoms adhere longer together, which means iron not as fluid as desired.

On the other hand if you had chosen your irons with a variation in analysis but the total mix giving some average analysis you would then have iron going into the mix varying in physical structure as seen under the microscope, having a strong affinity for each other, giving the same average analysis as required in the castings, which in melting would give a more radical separation and a consequent more fluid iron, also a more regular melt and probably convince you that for once your tuyers are working all right.

The simple point which I am trying to illustrate is that affinity in irons means strength and we should so endeavor in making our mixtures for special purposes, that we will use irons that will become fluid readily and when they are in this fluid state will combine to the best advantage. This can be done intelligently if we will use the information that is being given to us daily by our microscopists and chemists.

Journal of the American Foundrymen's Association.

VOL. XII. JUNE 1903. PART, I.

RECOVERY OF NICKEL FROM SCRAP ANODES.

BY A. K. BECKWITH, DOWAGIAC, MICH.

While it is the usual practice to melt scrap nickel andoes in the crucible, our company fitted up a cupola for the purpose. As nickel is more infusible than iron naturally more coke is consumed and the charges must be made accordingly. We use a ratio of one to one for the bed, and two and one half to one for the charges. The following is the result of one run which required two heats. The total amount of scrap melted being 875 pounds.

The scrap was worth $218. 75, the coke used was 640 lbs., valued at $2. 25, Molder's time $3.00, labor $2.00, or total cost $226. 00.

The yield was 635 pounds of nickel anodes, which at 50 cents a lb. made $317 50, then 75 lbs. scrap worth $18. 78 making a profit on the operation of $110.25.

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THE ORGANIZATION, MAINTENANCE AND MANAGEMENT OF A MODERN PATTERN SHOP.

BY JOS. LEON GOBEILLE, CLEVELAND, OHIO.

In no department of metal founding is so large a proportion of the outlay wasted and so little care and sense bestowed as in the pattern shop. This being axiomatic we shall simply discuss remedies and improvements.

The building is important; the plant and the placing of the tools more important, and, most important of all, the system of work and management. As it is not easy to describe a building in words, a drawing has been prepared which approaches almost perfectly to the requirements. It must be light throughout—no dark centers as in a square room; it admits of supervision in its entirety from the foreman's table and is not too wide to permit of doubling up men on a big pattern—a matter of some moment on a hurry job. The shop should be a single-story detached building, or if storage is needed, have the shop on the top floor, plenty of light, good heating by hot water system; sanitary arrangements and fixtures of the same quality as you would order for your own home. Pure water, ice and the best castile soap should be provided free, and a room set aside and furnished with bandages and other things needed in "first aid" emergency.

A 4" stand-pipe should be erected with a Y to whicn is connected coils of 2" hose for use in case of an incipient blaze. Of course no fire will be allowed anywhere in the shop; your glue pots will be heated by steam and your artificial light must be electric.

Your lumber room is constantly replenished with air-dried ready-to-use lumber. This lumber should be stood on end, i. e., the planks racked vertically, turning each end for end every ten

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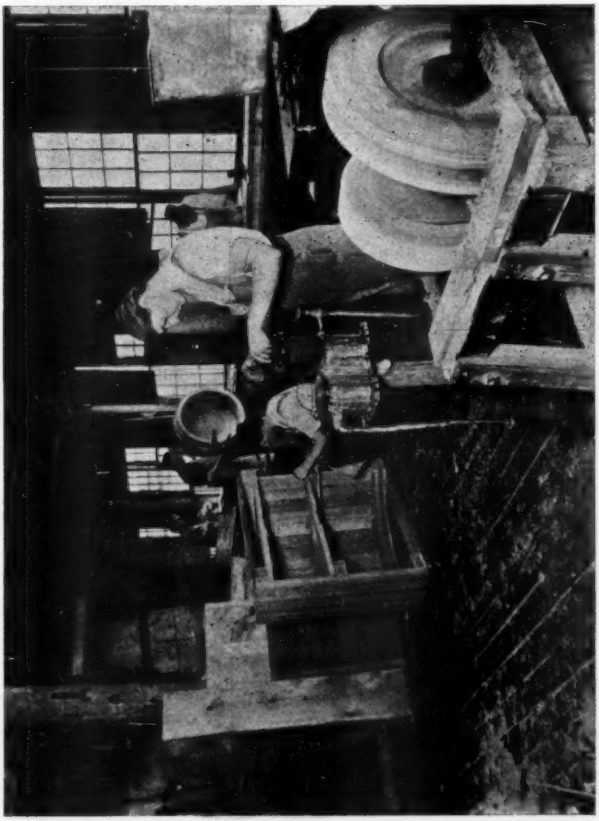
days. Now that lumber is so large an item of expense, careful grading will be necessary. White pine is still preferable even at the price, but maple, poplar and white wood can be substituted in places, especially for segments and framing.

You will note that the lumber room is at one end of the first wing, and the varnishing room in the same position on the other wing, and the tools are placed so as to permit of consecutive operation from start to finish, thereby saving time in retracing steps and rehandling material.

A combination rip and cross-cut saw comes first; next in line a 24" joiner to get one side of the plank true and out of wind; then the planer to reduce to the required thickness—notice that the band and jig saws are next in line; then the segment machine and various lathes.

Showing twin glue pot, which admits of one being kept in condition, while the other is in use on a bench or pattern.



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In placing machines pay particular attention to "clearance". A cross-cut saw must admit of one foot being sawn off from either end of a 16′ plank without collision with another tool, operation or workman. A jointer or rip saw must allow for working up to 16 feet long and 24 inches wide under similar conditions.

A large cast iron surface plate is very handy for starting frames, housings, or any large work which must be absolutely level.

I believe the hand or bench trimmer is a detriment to rapid work, and I have had as many as fifty in operation only to be finally abandoned. A better device is the power face plate with plain angle gauge.

I cannot name the *best* tools, of course, but some of the best advertised saws, lathes, etc., are unsatisfactory.

There is no good glue pot on the market. I have designed a twin steam pot which is all right if connected with a sewer to draw away the product of condensation; it is operated by live steam and admits of one pot being used on a job or on the bench without the cooling of the other, an important trifle—the photograph and drawing are explanatory.

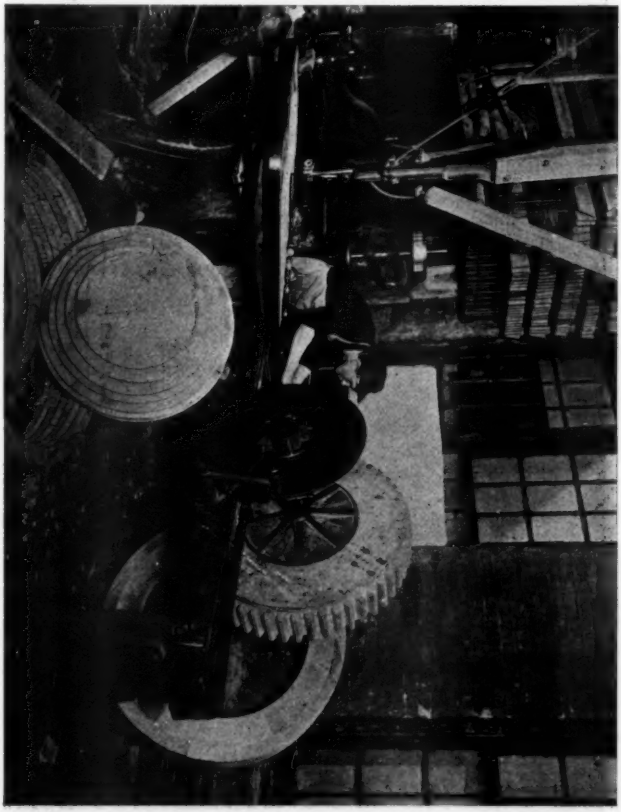
A segment machine is a great time saver. A boy at $1.25 per

Mr. Gobeille's Segment Machine which puts up any D. from 4 in. to 52 in., at an average cost for labor of 1 cent a course of six segments.

day will "lay up" and glue 100 courses of six segments each for a day's work; about what eight journeymen would do on shute-boards at 35 c. an hour. No such machine is, however, on the market, and I give a cut of it herewith.

Of course if you make only a few gears you will need a

Shows boy cutting open gear at cost of 2c. per inch of D. plus width of face.



gear cutter; there are none on the market; we had to make ours, which is the only one I know of that actually turns out either involute or epicycloidic gears, without skilled labor to handle it. Any

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Showing practical wall face plate lathes for large work. This one will swing up to 22 feet in diameter.

bright boy can run it. It is thought to be worth 50c. an inch of "diameter plus face" to make teeth in hard wood for ordinary spur gearing by skilled hand-work at 40c. per hour, this is honest and perhaps exceptional output. This machine will cut gear teeth for 2 c. an inch.

A core box machine is a money saver. There is one on the market which is pretty near perfection.

There is no larger joiner on sale than 24 inch. I have found that 40 inch is a low limit and some day shall cut our patterns to make a 60 inch. In large turned work—especially when laid up on a segment machine—a big jointer will surface courses for a fraction of the cost when done on the lathe, the usual way. If your foreman has the practice of doweling his segments—a commendable habit—then you need a dowel machine. A good one costs only about $50.00.

For many years it was a problem to get out large turned work. Anything heavy over 10 feet diameter would chatter. I show a photograph of a big face plate hung from oak timbers 12 x 12, which are built into the end wall of the building; this works perfectly and handles anything up to 22 feet diameter.

There is nothing so good as the wooden fillet, but leather and lead are cheaper.

A flexible shaft suspended above your housing table with, say, five sizes of round rose cutters, will work the finest fillets in a pattern you ever saw, and do it out of the solid. The same rig makes a good sand-papering machine for curves and corners.

Three grindstones are absolutely necessary; one medium, one fine-grain—flat and in perfect condition for planes, chisels, etc.—one medium-grain for gouges and curved blades.

A planer bit grinder; automatic saw set; brazing kit, and an air-brush varnisher will about complete your inventory of necessary tools.

In a certain shop of which I have had some casual knowledge the system is as follows :

The Superintendent is a mechanical engineer, graduate of a technical school, who never made a pattern or cut a chip in his life. He is held responsible for the putting of the work into the

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shop. It must be laid out right, go to the proper gangs and be satisfactory as to plan of construction, i. e., best and latest method of moulding, and if steel, extra risers or wings if necessary to subdue abnormal shrinkages. Every different pattern for a steel casting is a new problem. The Assistant Superintendent is a first-class pattern maker, thirty-six years of age, who is held accountable for getting the work out of the shop at right cost and in the promised time.

This shop is run in a combination of groups of specialists. The gangs contain seven men each—Mill, Dimension, Assembling, Finishing and Varnishing Gangs.

The Assembling and Dimension Gangs are duplicated many times, one gang making nothing but beds, frames, or housings, another steam, and air, and hydraulic cylinders, a third intricate cored work as valves, injectors, etc.

The gang-boss gets $5.00 a day. If he severs his connection with the company for any cause, a new man is elected from the gang to take his place. The gang has one vote, the Superintendent one, and the body of gang-bosses one vote. This man thus chosen, though receiving only say $3.00 a day, is immediately raised to $5.00 and is privileged to name the "tail man" to fill out his quota. This new man receives $1.75 and is usually a relative from some foreign country, generally a cabinet maker or jointer and often a fine mechanic who develops into a gang-boss himself in time.

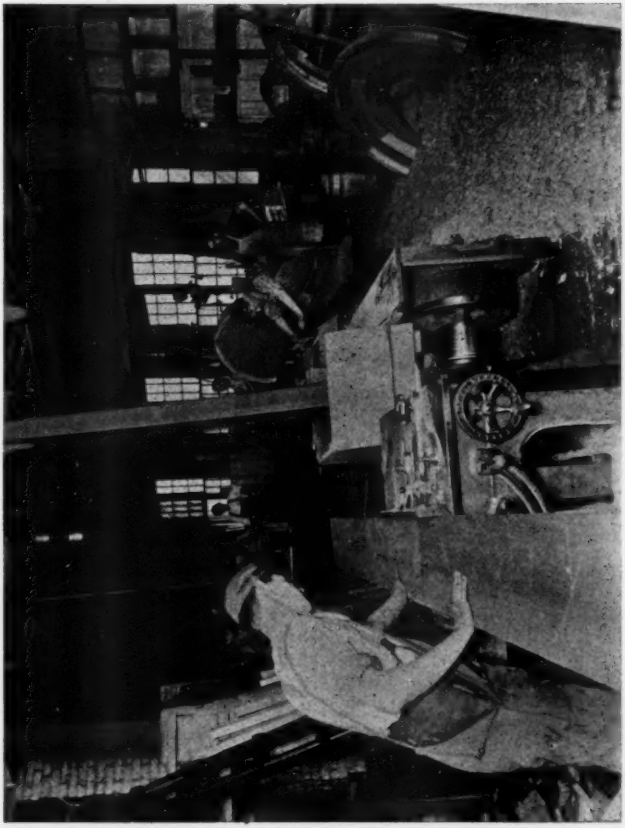
Once each week the Superintendent, Assistant Superintendent, all the gang foremen, the electrician, and the machine man, together with the President of the company, get together for conference. At this meeting all troubles are adjusted. Absolute free speech prevails. If a gang-boss has a hunch to advise the removal of the President or Superintendent to Hades, that is his right, and he exercises it with impunity and without prejudice. As every gang-boss thinks he is discriminated against, in the matter of workmen, it is a chance to fix things up and make exchanges, e. g., an "A. P. A." and a Roman Catholic, a Free Silver and a Gold man, do not get good results side by side, both spend valuable time in argument, are unhappy and discontented, so they are best separated and put into different gangs.

Each gang-boss signs a receipt to the gang below for his ma-

terial—if the stock is insufficient, or in error in any way, he has no redress, but his gang must make it good in its own time and at its own cost so far as labor is concerned.

Sometimes a gang-boss will pass up a defective bill of work

Shows staggered tandem plan. Plank works to jointer, then back to planer, which is to the right of saw—brings stuff back to starting point, sawed to size, and planed to thickness.



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maliciously, to avoid "making good," but if the next boss does not discover the error he gets no sympathy, for the Assistant Superintendent tells him it "serves him right if he can't check up his own stuff."

In this particular shop the Varnishing Gang is composed of women and girls—they are experts and earn an average daily wage of $1.25. They are twice as effective and ten times as well satisfied as the men, whose places they filled and who received $2.25 per day of ten hours.

It will be apparent to you that this gang system dispenses with skilled pattern makers in some gangs to the amount of one-half or more. In the Mill Gang there need be but *one* pattern maker; only two or three in the Dimension and Assembling Gangs; not one in the Turning Gang, in which there are seven men and only six lathes. Each man runs his own special lathe and no other, while the gang-boss neither tools or spins - he earns his 50c. per hour and has it just as easy as if he were a walking delegate.

The purpose of this paper is to be suggestive and helpful. Many of you have not steady work for enough men to pay you to run a large shop as pattern work is never constant - it is either a "feast or a famine;" but suppose, say, three concerns should join forces and run a pattern shop in common of only twenty five men then the organization might be something like this:

A committee of five, one from each joining company with the Superintendent and Clerk of the pattern shop *ex officio* - this committee to meet weekly and plan the placing of the work on an equitable basis. You have, in addition to Superintendent, 24 workers. These should be divided into four gangs of five men each, viz.:

A Mill Gang—Which shall get out rough lumber, plane and saw, but not dimension.

Dimension Gang - Which shall put the Mill Gang product into lengths, shapes, and fitness.

Assembling Gang - Which shall build this product into pattern form.

Finishing Gang - Which takes care of rounds, fillets, dowels, draw and rapping plates, sand-papering, etc.

You have four men left—two will do the turning, one on

small, one on large—the other two will varnish and put on the symbols and lettering.

Gentlemen, I have endeavored to be frank and simple with you. The question of cheap patterns is one of organization, truly no secret or mystery.

I have told you all I know about it, which is not a terrible sight. My final request is that you will consider my effort of no importance and let things go as they are, for you are paying on an average about 50 per cent. too much for patterns made in your own pattern shop, which is a beautiful margin for me to work on.